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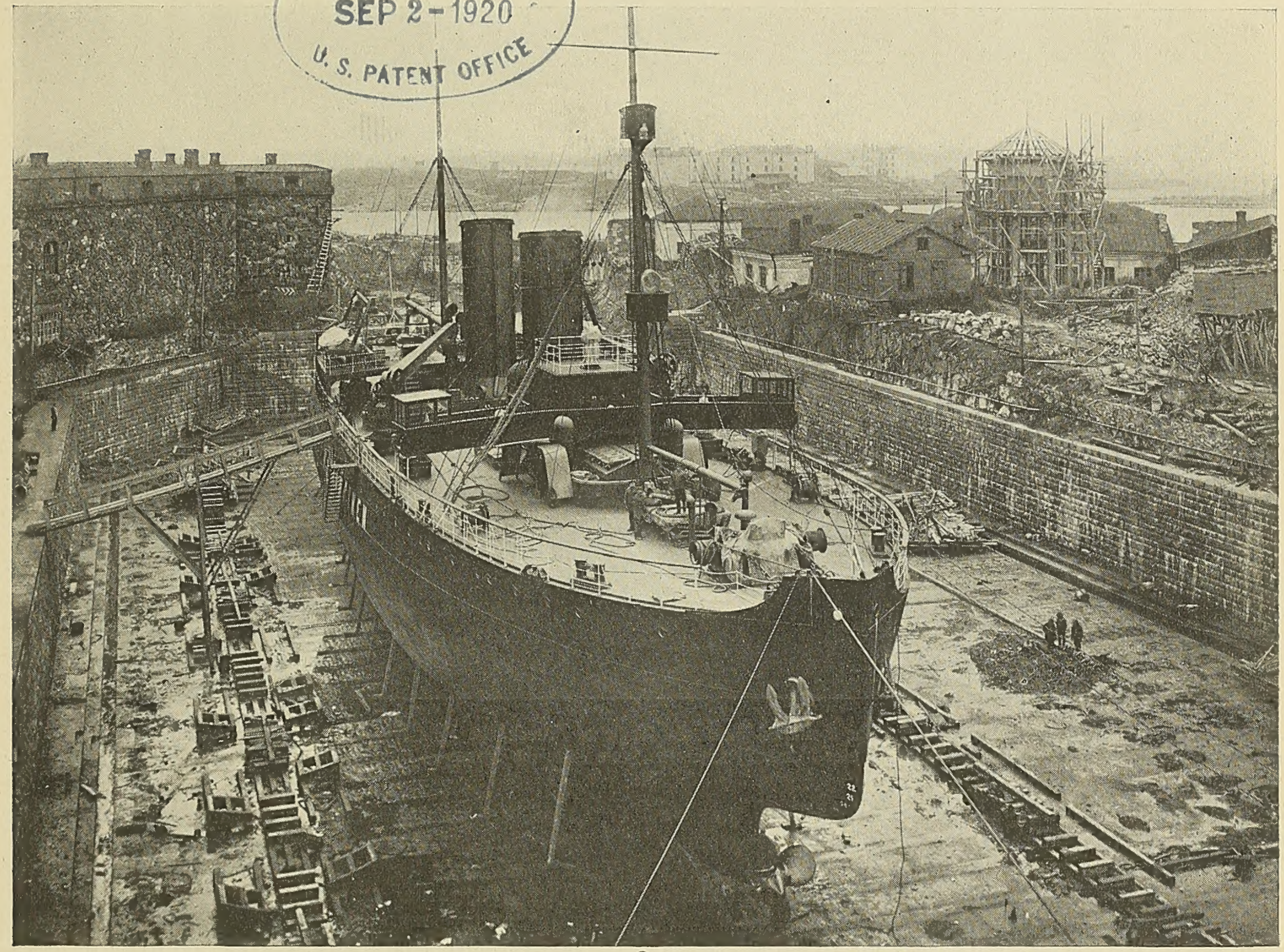


Fig. 1.—Deck View of Ice-Breaker *Vainamoinen*. The Vessel is in Dry Dock at Sveaborg Fortress

Ice-Breakers

Characteristics of Vessels Designed Expressly as Ice-Breakers —American and European Practice—Work in Pack-Ice

BY JOHN FLODIN

THE year 1851 is given as the date of the first record of a vessel built expressly for the purpose of forcing its way through ice. It should be noted that this is the period in the history of navigation and shipbuilding when steam and steel were already the acknowledged masters of the ocean and when the screw propeller was rapidly gaining friends. It was in 1851 that Fincham wrote his famous paper on screw propulsion, in which he deprecated that engineers in England were reluctant to admit the superiority of the screw, in spite of the towing test between the *Alecto* and the *Rattler*, which in 1845 had given such conclusive evidence in support of his views. The advent of the screw propeller may be regarded almost as a prerequisite to the development of the ice-breaker, for paddle-wheel propulsion would, of course, offer very serious obstacles to navigation in ice.

However, little is heard of ice-breakers before the year 1871, when the ice-breaker *Eisbrecher I* was built by Fr. Steinhaus in Hamburg, to keep the Elbe open.

Classification of Ice-Breakers

The *Eisbrecher I* is generally regarded as the first successful vessel built expressly and solely for the purpose of keeping harbors open to winter traffic. Some ice-breaker characteristics have, however, been incorporated in many vessels built primarily for other purposes, both

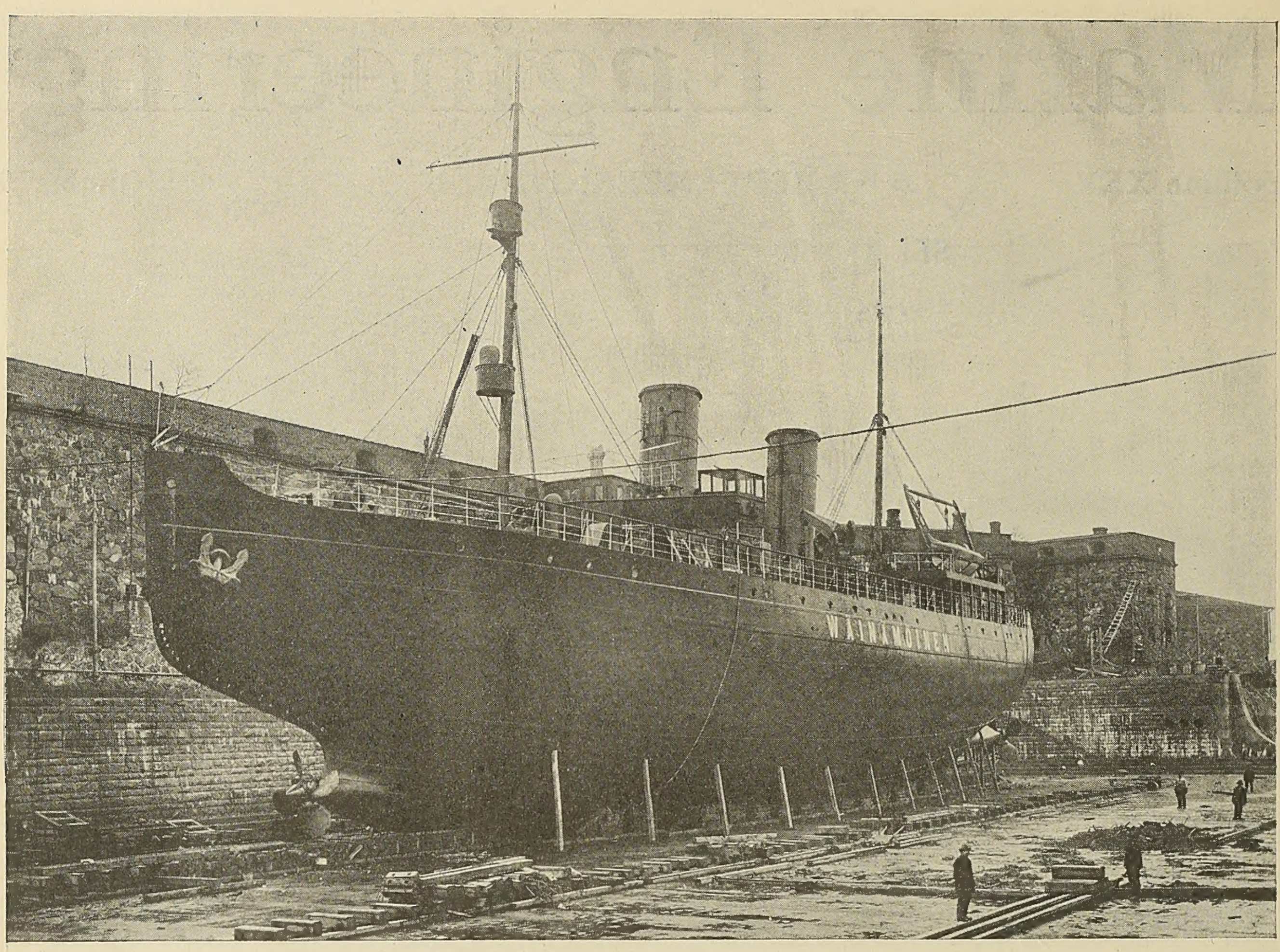


Fig. 2.—Bow View of the *Vainamoinen*. The S-shaped Stem, the Angle of Attack, the Fine Run and Buttock Angles, and the Chubby, High-Speed Bow Propeller Are the Chief Points of Interest. Note Also the Sweep of the Bottom from Keel to Waterline

before and after the time of the *Eisbrecher I*, so that we may say that ice-breakers can be classified in two groups:

(1) Ice-breakers pure and simple.

(2) Commercial vessels incorporating some of the characteristics and qualities of ice-breakers.

In vessels of the first group, the entire ship is given over to the machinery, equipment and crew necessary or desirable for ice-breaking purposes, while in the latter class the extent to which deadweight capacity, cargo or passenger space and speed are sacrificed in order to enable the vessel to force its way through ice becomes an economic question the solution of which depends largely upon the ice conditions in the ports to which it is intended to run the vessel.

Although the second group offers many points of interest, as much because the vessels belonging to it are steadily growing in both number and size as because of the often delicate task of balancing ice-breaking power with economical operation, we shall here confine our attention to vessels of the first group. This group is, in turn, commonly subdivided into:

(*a*) Vessels of the European type.

(*b*) Vessels of the American type.

The European Type

To the designer of *Eisbrecher I* is due the credit for having ushered into the world not only the first successful ice-breaker, but also the fore-runner of the so-called European type of ice-breaker. Curiously enough, this vessel incorporated all the chief characteristics that until relatively lately were regarded as necessary and sufficient for successful ice-breakers.

The principle of ice-breaking employed was to crush the ice downward, rather than to try to plow it to the sides, the stem having been given such a slope that the force of the vessel's movement against the ice gives rise to a vertical downward component of a greater magnitude than the horizontal forward component. To force heavy ice, or pack-ice, it is, however, often necessary to back away and to run against the ice at full speed, thus driving the bow of the vessel some distance on top of the ice.

The forward part of the vessel is somewhat raised, and its weight, augmented by water ballast, serves to crush the ice. For work of this nature, a vessel of extremely heavy construction and fitted with extraordinarily powerful engines is, of course, necessary.

Proportions and Lines

Another conspicuous peculiarity of the ice-breaker is the breadth to length ratio, which usually is about 1 to 4. The reason for this is to be found in another peculiarity, namely, the great stern draft, given the vessel in order to keep the propeller blades as much as possible out of danger from solid ice. It is principally for the purpose of securing good stability in spite of the great draft that the breadth is made so large. Since vessels of this type are not intended to navigate in open sea-ways, there is no great disadvantage in having a somewhat unusually large metacentric height, but great breadth also offers the advantage of better maneuvering qualities in narrow waters.

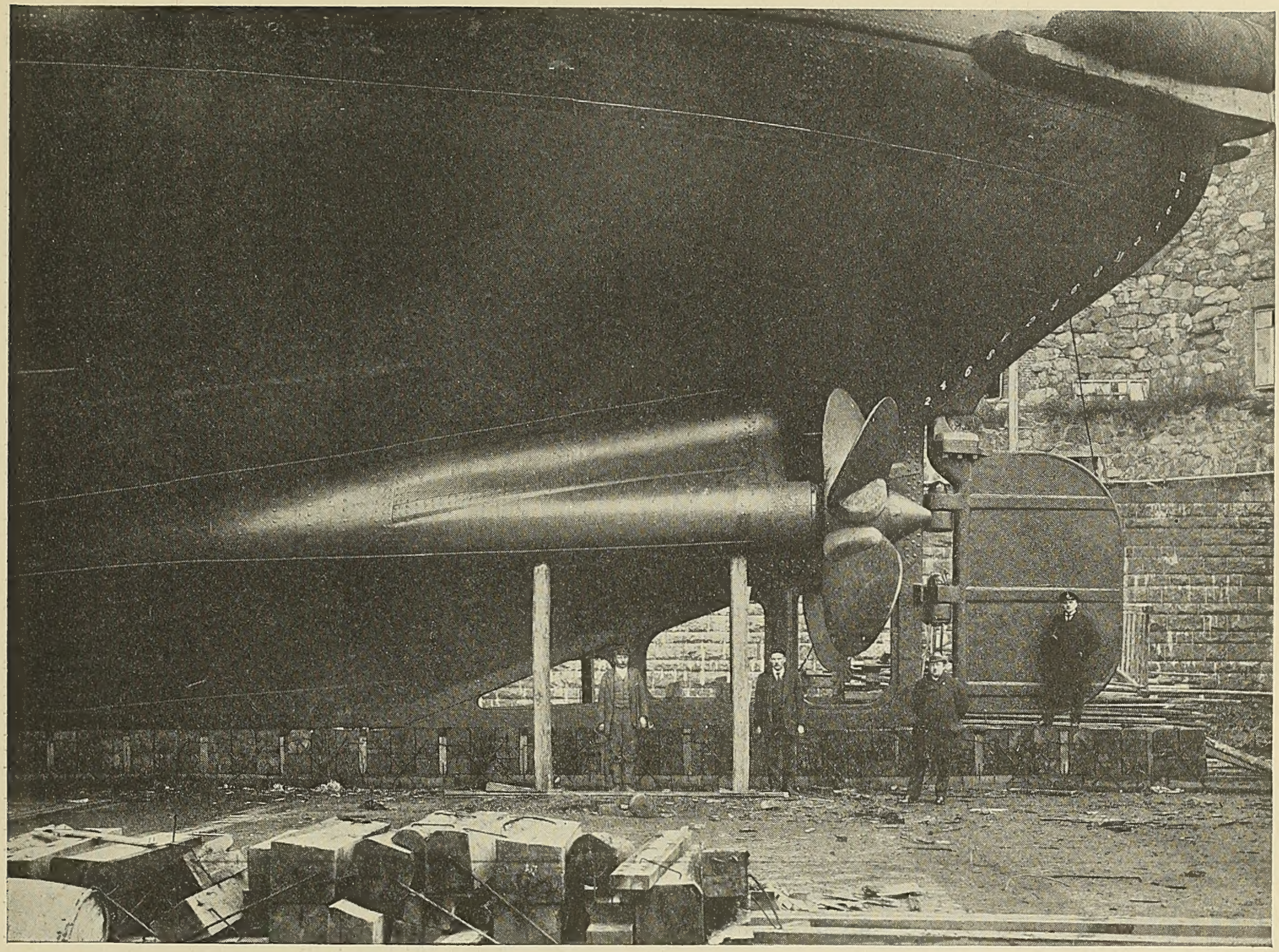


Fig. 3.—Stern of the *Vainamoinen*. Note the Heavy Propeller Blades, the Sturdy Rudder Construction and the Full Load Waterline as Compared to the Relatively Fine Run

and of making the wake, or the cut in the ice, broader.

As to the lines, the most notable difference between the ice-breaker and an ordinary mercantile steamer is seen in the great deadrise and bilge radius of the former, which gives an almost yacht-like underwater body. This body form affords the broken-up ice a better opportunity to get away, as it may disappear under the vessel, where it becomes further broken up as it moves towards the stern. Aft the waterlines below the load waterline are made quite fine, so that the flow of water to the wheel and the rudder is considerably more parallel than is usual in commercial vessels of anything like the same breadth to length ratio, giving again a yacht-like effect. The stern is, however, made full at the waterline, a low counter of considerable size being provided. The reason for this is the need to give the after body above the load waterline as much buoyancy as possible, so as to keep the stern from sinking unduly when the bow is run on the ice. Furthermore, a full load waterline aft tends to cause a large stern wave, which helps in breaking up loose blocks of ice.

Some of the older ice-breakers were given a flare along their whole length, but the modern practice is to give a quite considerable tumble-home above the load waterline, so that the entire side of the ship forms a continuous convex surface, except for the hollowing at the run. The bellying of the ship's side at the waterline tends to prevent jamming in the ice and offers the further advantage that the vessel, in case it should be frozen in, can be freed by listing. For this purpose the latest ice-breakers are, in fact, provided with wing ballast tanks so connected by means of pipe lines that the water may be pumped from one side to the other.

The *Eisbrecher I* had a rather full bow with a sloping stem, a construction that was so successful that it was first copied and later modified in an effort to produce something even more effective. The result was a spoon bow, which, though very satisfactory in breaking clear ice, soon showed itself impossible in ice covered with snow. Snow, and especially wet snow, has the unpleasant characteristic of walling up before and around the bows of the ice-breaker, forming a cushion ever increasing in size and hardness, making the task of driving the bows of the vessel on the ice ever more difficult and perhaps finally impossible.

On the basis of the experience just gained, the bow construction of the *Eisbrecher I* was returned to, and subsequently the lines forward were made materially finer, giving a rather sharp bow. This soon showed itself in many respects so much superior to the fuller bows that it immediately won favor. The sharper bow construction was first proposed by the Finnish engineer R. Runeberg, who, as a member of the committee of experts employed by the Finnish government to draw up specifications for the *Murtaja*, objected to the spoon bow, pointing out that all the angles of attack should be made quite fine, that is, the angle of the stem with the horizontal, the entrance angles of the waterlines, and the angles of the buttocks with the horizontal. The *Murtaja* was, however, built with a spoon-shaped bow, but it was the last ice-breaker so constructed (1889).

Particulars of Typical Ice-Breakers

NAME AND OWNERSHIP	LENGTH OVERALL FEET	BEAM AT D'K FEET	BEAM MLD. FEET	DRAFT AFT, COAL ON BOARD FEET	DISPL. TONS	INDICATED HORSEPOWER FOR'D	INDICATED HORSEPOWER AFT	INDICATED HORSEPOWER TOTAL	SPEED IN CLEAR WATER, KNOTS	STEM ANGLE OF ATTACK, DEGREES	TYPE OF BOW	YEAR BUILT	APPROX. COST, DOLLARS	WHERE BUILT	REMARKS
EUROPEAN TYPE.															
Berlin (Stettin)	141.2	35.4		16.0	630		900				Spoon	1889	79,400	Stettin, A. G. Vulcan	
Murtaja (Finland)	156.1		35.8	17.0	824		1,260			33	Spoon	1890	138,400	Stockholm, Bergsunds Mek. Verkstad	
Eisbrecher III (Hamburg)	146.3	36.05		15.1	860		1,200			40	Full	1892	122,000	Hamburg	
Isbjorn (Christiania)	123.1	32.5		17.6[1]	630		1,200			45	Full	1893	74,200	Christiania	
Bore (Malmo)	133.1		29.0	13.0	400		600			40		1894	41,600	Malmo	
Isbrytaren II (Gothenburg)	140.2		34.0	18.8[1]	720		1,300				Full	1895	88,000	Gothenburg	
Stadt Reval (Reval)	148.0		38.8	13.5	865		1,600			30		1895	100,800	Stettin	
Sleipner (Copenhagen)	170.1		39.0	17.75	1,470		2,600		13.5	30	Sharp	1896	168,000	Copenhagen, Burmeister and Wain	
Isbrytaren (Stockholm)	141.2		31.0	16.5	616		1,000		12	40	Full	1897	84,000	Malmo	
Nadeschny (Vladivostock)	180.4		42.5	17.75	1,525		3,000			30	Sharp	1897		Copenhagen, Burmeister and Wain	
Avance (Åbo, Finland)	143.2		34.4	17.8	600		1,500		13.6		Sharp	1899	133,200	Kiel, Horaldts Werke.	
AMERICAN TYPE.															
St. Ignace / *St. Marie* (Ferries between Mackinaw & St. Ignace, Mich., R.R.)	302.2	52.0		17.0	3,640	1,800	2,200	4,000	16	25		1887 / 1893	340,000	Detroit	Ferries not ice-breakers pure and simple
Sampo (Finland)	202.2	43.0	42.0	18.25	1,850	1,200 (1,400)[2]	1,400 (1,600)[2]	2,600 (3,000)[2]	13.5	22	Sharp	1893	270,200		
Jermak (Russia)	302.6	71.0		25.0	8,000	2,500[3]	7,500	10,000[3]	15.5	20	Sharp	1899	798,000	Newcastle-on-Tyne, Armstrong, Whitworth & Co.	
Tarmo (Finland)	220.0	47.1	46.9	18.25	2,300	1,300 (1,450)[2]	1,700 (2,400)[2]	3,000 (3,850)[2]		22	Sharp	1907	326,400		
Peter der Grosse (Riga)	182.3	50.8	48.5	21.3	1,900	800 (1,200)[2]	1,800 (2,800)[2]	2,600 (4,000)[2]	14.5		Sharp	1912	352,000	Gothenburg	700 tons water ballast Cap. working and Ball. pumps 2,500 tons per hour
Vainamoinen[4]	300.0	60		21.0		2,400	3,600	6,000	15		Sharp	1914		Stettin, Vulcan	One of several sisters

[1] Draft with ballast.
[2] Figures in parentheses indicate horsepower with forced engines.
[3] Forward engine and propeller removed from *Jermak*, and bow rebuilt, in 1909.
[4] Ex-*Volynetz*, ex-*Tzar Michael Feodorowitch*.

The first vessel that incorporated Mr. Runeberg's ideas on bow construction was the Swedish gunboat *Svensksund*, designed by Mr. G. W. Svenson in 1891. Successful though this construction was, the sharp bow caused much unfavorable comment. Many designers regarded it as too weak, and subsequent vessels were consequently given a bow that either approached the full form of the *Eisbrecher I* or the fine lines of the *Svensksund*, in accordance with the designer's idea of strength, durability and efficiency. In the appended table are given the stem angles of attack and type of bow for a number of typical ice-breakers.

The American Type

The so-called American type of ice-breaker is differentiated from the European type by the one peculiarity that vessels of the American type have a propeller forward. As a consequence of this, the drag is lessened or entirely obviated.

The efficiency of the forward propeller in breaking through ice was discovered on the Great Lakes, where it had been found that a loaded vessel could back its way through ice when it could not get through otherwise. It seemed evident that the screw, in backing through the ice, served the complex purpose of propelling the steamer, of disturbing the water under the ice that was to be broken and of helping to move the broken-up ice towards the rear. Deprived of the solid support of still water, the ice was relatively easily broken through.

Acting on this theory, Mr. Frank E. Kirby designed the railroad ferries *St. Ignace* and *St. Marie*. Although these vessels cannot be classified as ice-breakers pure and simple, their particulars are given in the appended table in order to afford a comparison with the later vessels that were inspired by the ferries. For these vessels showed themselves to be such excellent ice-breakers that the idea was promptly copied by European designers. In fact, the Finnish government, which was then contemplating building another ice-breaker, sent a commission to America to study the new ideas incorporated in the *St. Ignace*. As a result of the work of this commission, the bow propeller was called for in the specifications for the *Sampo*, which was built in 1893 for the Finnish government.

This, so far as I know, was the first pure and simple ice-breaker of the American type ever built in Europe. But it was soon to be followed by others. The Russian government, perhaps in a spirit of giantism, decided that it should not be outdone by its small neighbor and ordered the huge ice-breaker *Jermak* (or *Ermak**), which was designed by Admiral Makaroff.

Large as the *Jermak* is, she has not been an unqualified success, either from an economic viewpoint or as an ice-breaker. She was built primarily to operate in the Gulf of Finland, and her first duty was to keep the port of Petrograd open. One might well think that, if this task is at all within the realm of human endeavor, the *Jermak* should be able to do it with her 8,000 tons displacement and 10,000 indicated horsepower. But the services she was actually able to perform—reports of the Russian

* For illustrations of the *Ermak*, see article on Shipbuilding in Encyclopedia Britannica.

naval engineers to the contrary—were not materially greater than those performed under practically identical conditions by the *Sampo,* a vessel of but 1,850 tons displacement and a maximum of 3,000 indicated horsepower.

Captain L. Melan, a veteran in ice-breaker work, who at that time was commander of the *Sampo,* has expressed to me the belief that the reasons why the *Jermak* did not make a better showing were that she was not properly handled, that she was not properly designed, and that she was altogether too large. The first indictment seems to some extent supported by other evidence. The second and third statements may be regarded as coinciding, for is not the choice of dimensions the first step in every design?

It seems very probable that a vessel of the size of the *Jermak* would be extremely difficult to maneuver in heavy ice, and all the more so when the waters are as narrow as many of the passages in the Gulf of Finland are. The *Jermak* has, however, furnished another very valuable lesson in ice-breaker design.

In 1909 it was decided to send her to the Arctic, but it was feared that the work in the heavy ice of the Far North would endanger the bow propeller. She was consequently sent back to England to be dry docked, and there the entire bow was reconstructed and the forward engine taken out. It is said that the official report, presumably made by the gentlemen who ordered the work done, states that the removal of the forward engine made no appreciable difference in the ship's ability to break ice. This, however, is false, for where it now became necessary for the *Jermak* to stop, back and get a good, long start so that she could break her way through the ice by running her great weight on it, the *Sampo*—a vessel, remember, of less than one-fourth the displacement and about one-third the horsepower of the *Jermak*—could often go through without a single stop. It seems that this experience would conclusively show the value of the forward propeller, even if there were no other evidence available.

The mere fact that the latest ice-breaker built for the Russian government, the present *Väinämöinen,* was ordered with a forward engine appears to be a confession that the removal of the bow propeller from the *Jermak*

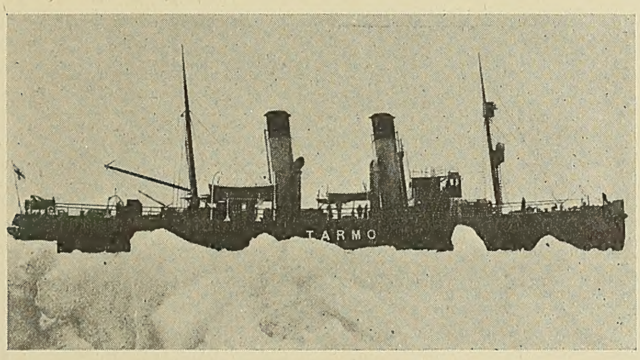


Fig. 4.—The *Tarmo* in Relatively Light Pack-Ice

was a mistake. But the efficiency of the forward propeller need not be based on the experience of the *Jermak* alone, for it is a matter of common observation. It has often been noted that when an ice-breaker forcing clear ice is running full speed ahead, with the bow propeller working, the water forward of the vessel is sufficiently disturbed to cause ice up to from four to six inches in thickness to break before the stem actually reaches the edge of the solid ice. The ice is, so to speak, torn to pieces by the suction of the bow propeller.

In pack-ice the bow propeller is, however, of even greater importance. This will perhaps be better understood if the formation of pack-ice is first considered.

Under ordinary wind and temperature conditions the ice will freeze to a certain ragged line, beyond which any new ice that may be formed breaks up before it can attain the thickness of permanence. If the temperature remains low and the winds are moderate, the ice may freeze to a thickness of several feet and may be covered with a heavy blanket of snow. If now a storm arises in a direction towards the edge of the ice from the open water, the wave formation will continue under the ice. Not only is

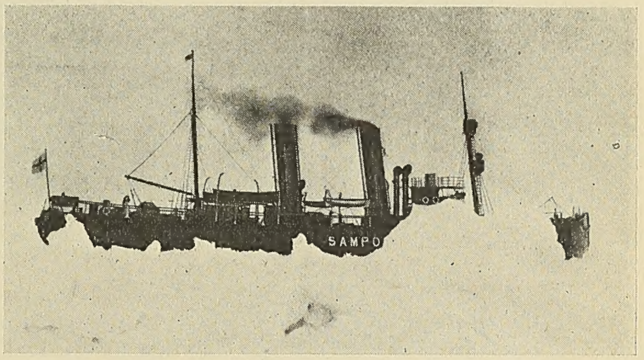


Fig. 5.—The *Sampo* at Work in Pack-Ice

the support of the ice thus made discontinuous, but a heaving movement is started causing ice blocks to break loose. These blocks, varying in size between very large limits, are tossed by the waves and driven by the wind until they form a field consisting of many thicknesses of the original ice, some blocks being piled on top of each other, while other blocks, sometimes quite large, are standing on edge or held in an inclined position.

WORK IN PACK-ICE

This mass may or may not freeze together into a solid field. In either case, the specific gravity of this mixture of snow and ice is often so low that but one-tenth of the mean thickness of the ice is below the surface of the water, while a ragged nine-tenths form a field that is all but unpassable for the human animal, full as it is of treacherous holes and crevices that often are covered with snow-slush that make them appear to be solid ice.

It is in this sort of ice that the skill of the commander of an ice-breaker is tested most severely. He can never tell how hard the ice blocks are frozen together, nor how soon the whole mass may begin to move. If he is foolhardy and drives his vessel into loose pack-ice, or into pack-ice that may become loose because of the working of the vessel, the lateral pressure that the ice exerts on the sides of the ship may become so great as to stop the ship through friction. And once a vessel is so stopped, it is impossible to move her with her own power, for the friction of the ice will, of course, be greater when the vessel is at rest than when it is moving. There is still hope of moving her, however, without calling in aid from the outside. Ice-anchors may be led out, so that the pull of windlass and winches may be added to the pull of the main engines, and in some cases blasting may be resorted to with good results.

It is under such ice conditions as these that the bow propeller is most effective. Through its continual churning it serves to draw blocks of ice and snow-slush towards the stern of the vessel, in which work the aft propeller or propellers naturally assist. It is, in fact, a principle of ice-breaker design that the length of the vessel must be so balanced with the power plant that the throw of the forward propeller and the suction of the aft propeller must meet somewhere near the middle of the vessel with sufficient force to carry the ice towards the stern even when the vessel is standing still. Much ice that otherwise would only be plowed to the sides, where it would serve to increase the friction, is by this means washed under the vessel and then aft.

This kind of work is, of course, extremely hard on the propellers. It is by no means an exception that the blades strike large blocks of ice; nor is it an exception that, when the vessel is forced into pack-ice, the forward propeller is driven into the ice so hard that it suddenly stops. This sort of service naturally necessitates extremely heavy propeller construction and engines, especially the forward engine, so designed that they are as nearly shock-proof as possible. It is evident from this that oil engines, at least in their present state of development, are not suitable for ice-breaker work. Producer gas engines have been proposed for the stern screws, while the bow screw would be driven by a reciprocating steam engine, but it does not seem likely that this sort of arrangement would prove satisfactory.

Some Ice-Breaker Data

The table given on page 710 is intended to show in a fairly representative way the changes that time has wrought in ice-breaker construction. It will be noted that, with the exception of the *Jermak,* there is but one vessel of more than 2,300 tons displacement, namely, the *Väinämöinen,* whose displacement is somewhat less than 5,000 tons. All the other ice-breakers are materially smaller, the two American ferries given on top of the group of "American Type" ice-breakers not being included in this comparison, since they are not purely ice-breakers.

The column headed "Stem Angle of Attack" gives the angle of the stem at or some little distance below the load waterline. In cases where the stem is S-shaped (see Fig. 2), the angle of the straight underwater portion of the stem with the horizontal is regarded as the angle of attack. The small angle of attack of the *Jermak* (20 degrees) has been offered as an explanation why that vessel has not proven more efficient. It is contended that when the angle is too small the bow may be driven on the ice as far as the forward propeller without raising the vessel sufficiently to give the necessary crushing force. It seems, however, that the great weight of the *Jermak* should offset this error, if, indeed, it is an error. In general, angles of attack of from 25 degrees to 35 degrees seem to have given the best results.

The Vainamoinen

As a good illustration of the latest ideas in ice-breaker construction, the *Väinämöinen* may be studied. She was built by Vulcan in Stettin, one of several sisters ordered by the Russian government, and was delivered just prior to the outbreak of the war. She has a length of 300 feet, a beam of 60 feet and draws 21 feet. The power plant consists of three reciprocating engines, all alike. Of these, the two after engines, operating twin screws, develop 1,800 indicated horsepower each, while the forward engine, operating the bow propeller at a higher rate of revolutions, indicates 2,400 horsepower, or a total of 6,000 indicated horsepower. Steam is furnished by six single-ended Scotch boilers. Coal is used as fuel, the bunker capacity being 700 tons, but provision is made for the use of wood in case coal should not be obtainable.

Even more interesting than the main power plant is, however, the auxiliary equipment, numbering some thirty-odd machines. It is perhaps not surprising to note that some of the pumps on board this ship—a ship that is now flying the Finnish flag, that was ordered by the Russian government and that was built at a German shipyard—bear the name-plates of a well-known American manufacturer, and that the engineer in charge has declared these pumps entirely satisfactory. The ballast pumps get an extraordinarily hard usage, since both the transverse and the longitudinal trim may be changed at any time and at frequent intervals. In order to facilitate this changing of trim, the ballast piping is so arranged that the water may be pumped overboard from any number of the tanks, or it may be pumped from one set of tanks into the opposite set of tanks. For example, if the ship is frozen in and it is desired to free her by listing, the ballast tanks in one wing are filled and then the water is pumped from these tanks into the tanks in the other wing. In the neighborhood of 300 tons of water are thus moved across the ship in from 12 to 15 minutes. The entire engine and boiler room equipment seems to have fulfilled every expectation. To quote the first assistant engineer, who very kindly showed me around in the machinery spaces: "The Russians may not be great shipbuilders themselves, but they certainly know how to demand and how to get good work from others." Which, perhaps, is a good substitute for doing good work yourself.

The deck machinery is electrically operated, which gives the advantage of obviating the use of steam pipes that may be found to be frozen when their service is suddenly most urgently needed. The ship is further furnished with an electrically driven, portable salvage pump, which may be carried in a boat or on a sled over the ice to a damaged vessel which the ice-breaker cannot othewise reach, either because of ice conditions or because of too shallow water.

The illustration herewith given of the *Väinämöinen* shows quite clearly the construction of the hull at the ends and the character of the propellers used. It will be noted that the stern is fairly fine, and that, while the load waterline aft is rather full, this ship has not the heavy counter mentioned as a characteristic of the older vessels. The bottom sweeps up to the waterline in a single long curve, giving a sort of modified V-shaped underwater body, so that one can scarcely speak of a bilge radius.

The impression of strength and sturdiness that the pictures give is an indication of the heavy, solid construction that is the first characteristic of all ice-breakers.

A 10,000-Ton Floating Dry Dock for Schiedam

The New Waterway Shipbuilding Company has recently installed at its Schiedam shipyard, near Rotterdam, a floating dry dock having a lifting capacity of 10,000 tons, built by Swan, Hunter and Wigham Richardson, Ltd., at Southwick, near Sunderland, England. The dock was ordered by Messrs. Furness, Withy & Company, which has the chief interest in the New Waterway Shipbuilding Company. It was built during the war and was at once commandeered by the British Admiralty and towed to the Invergordon naval base in the Cromarty Firth.

The dock is 500 feet long overall, 104 feet wide outside and 75 feet wide inside the walls. The pumps, obtained from Gwynnes, Ltd., of London, are driven electrically, the current being taken from a power station on shore. The dock is of the bolted sectional type, composed of three sections, each of which is in effect a complete box dock, and they are bolted together. When self-docking is required for painting or repairs, the three sections are disconnected and then any two of them can lift the third section out of the water.

This new dock was quite invaluable at Invergordon, being able to accommodate light cruisers as well as smaller ships. As it was comparatively near Scapa Flow, a great

Fig. 1.—The *Asbury Park* as She Appeared in Service in New York Harbor

deal of time was saved by not having to send many ships of the Grand Fleet to Rosyth or more southern ports.

When the Admiralty at last released the dock it was taken to Schiedam by the International Tug Company, of Rotterdam. Three powerful ocean tugs, the *Humber, Schelde* and *Seine* were used for the purpose. The towage was hampered by bad weather and head winds, but in spite of such unfavorable circumstances it was accomplished without any damage whatever being done to the dock. Within three days of arrival at Schiedam, the dock successfully lifted a ship and has continued to be busily employed.

Steamer Asbury Park in Service on the Pacific Coast

BY H. L. DES ANGES

FOR nearly fifteen years one of the most popular passenger steamers in service in New York harbor was the *Asbury Park,* operated by the Central Railroad of New Jersey on the Sandy Hook route from New York to Atlantic Highlands, N. J. She was a steel twin-screw 20-knot flyer built by William Cramp & Sons Ship and Engine Building Company in Philadelphia in 1903. Three years ago C. H. Hatch, of Hatch Bros., San Francisco, which operates the Monticello Steamship Line between San Francisco and the Napa Valley, came to New York to canvass the field for vessels suitable for operation on this line. After a careful survey, Mr. Hatch bought the *Asbury Park* and had her prepared for the trip to San Francisco, which was made via the Panama Canal under her own steam.

Originally the *Asbury Park* was equipped with four Scotch boilers, two of which were double ended and two single ended, designed for coal burning. Subsequently these boilers were replaced with nine watertube boilers with which the vessel made the trip to the west coast. Since her arrival in San Francisco the watertube boilers have been replaced by four shell boilers of the gunboat type. These boilers, in accordance with the prevailing practice on the west coast, have been fitted for burning fuel oil, thereby greatly reducing the number of the crew.

The *Asbury Park* has a length on the waterline of 297 feet 3 inches, a molded beam of 50 feet, and a depth of 17 feet. Propulsion is by two sets of four cylinder, triple expansion, reciprocating engines with cylinders 23 inches, 37½ inches, 43 inches and 43 inches diameter by 30 inches stroke, which at 190 revolutions per minute develop approximately 6,000 indicated horsepower. Designed for a speed of 20 knots, the vessel developed on her trials at the time she was built a speed of 20.5 knots.

The owners state that the venture in bringing the vessel from the Atlantic to the Pacific has proved thoroughly satisfactory and that the popularity which the *Asbury Park* has gained has fully justified the move. As can be seen from the illustrations, the appearance of the vessel has been considerably altered.

Fig. 2.—The *Asbury Park* as Altered for Service on the Pacific Coast

10,500-Ton Deadweight Cargo Carrier

Type of Vessel Under Construction for Shawmut Steamship Company at Chester Yard of Merchant Shipbuilding Corporation

THE Chester, Pa., yard of the Merchant Shipbuilding Corporation is building two 10,500-ton deadweight steel cargo vessels for the Shawmut Steamship Company, of New York. These vessels will be built and classed to the rules of Lloyd's Register of Shipping, class 100 A-1, and in compliance with the rules and regulations of the United States Steamboat Inspection Service.

Characteristics

The characteristics of each vessel will be as follows:

Principal Dimensions

Length overall	457 feet 0 inches
Length between perpendiculars	440 feet 0 inches
Beam, molded	57 feet 0 inches
Depth at side to shelter deck	39 feet 0 inches
Depth at side to upper deck	31 feet 0 inches
Depth at side to lower deck	22 feet 0 inches
Draft, designed load	28 feet 9 inches
Displacement at designed load draft	15,000 tons
Speed on designed load draft	13 knots

Capacities

Deadweight, designed load draft	10,500 tons
Cargo capacity, bales	470,000 cubic feet
Fuel oil capacity at 38 cubic feet per ton	2,400 tons
Drinking water tanks	29 tons
Reserve feed water	150 tons

General Description

The vessels are to be of the single screw, shelter deck type with machinery located amidships. A double bottom extends throughout the vessel between the forward and after peak bulkheads, which will be used for the stowage of fuel oil, with the exception of that portion in way of the engine space where the reserve feed water will be carried. There will be three deck erections, viz., a steel bridge house with accommodations on the shelter deck for the deck officers and on the boat deck for the captain with a wooden wheel house and chart room over, a steel midship house with accommodations for the engineers and petty officers and a steel house aft for the steering gear, entrance to quarters below, toilets, etc. The firemen and seamen will be housed aft on the upper deck.

Five cargo holds are provided and 'tween deck cargo spaces on the second and upper decks. Two steel pole masts with wooden topmasts and two king posts will be fitted carrying the cargo handling gear, lights, signals and radio antennae. Ten 5-ton steel booms and one 30-ton steel boom will be provided for handling the cargo.

Machinery Installation

The main propelling machinery consists of one set of turbines, of the cross compound type, and double reduction gears, arranged so that either turbine can be operated ahead or astern independent of the other. The steam pressure at the turbine throttle is to be 200 pounds per square inch without superheat, and the set is to be capable of developing 4,000 brake horsepower when the propeller shaft is running at 90 revolutions per minute. A thrust bearing of the Kingsbury type is to be integral with the reduction gears.

The machinery installation also includes the following:

One main condenser of the cylindrical type, two pass, with a total cooling surface of 6,000 square feet.

One centrifugal double suction type circulating pump of 7,000 gallons per minute capacity against a 25-foot head.

One set of two air ejectors, with steam at 125 pounds per square inch pressure, each capable of maintaining a vacuum of 28 inches with a condenser of 6,000 square feet cooling surface handling 60,000 pounds of exhaust steam per hour.

One combination air separator and condensing tank.

Two turbo-pumps for condensate, each pump capable of handling 60,000 pounds of water per hour, to draw against a vacuum of 28 inches and discharge against a head of 30 feet.

Two lubricating oil pumps, 7 inches by 7 inches by 12 inches, of the vertical duplex double acting type.

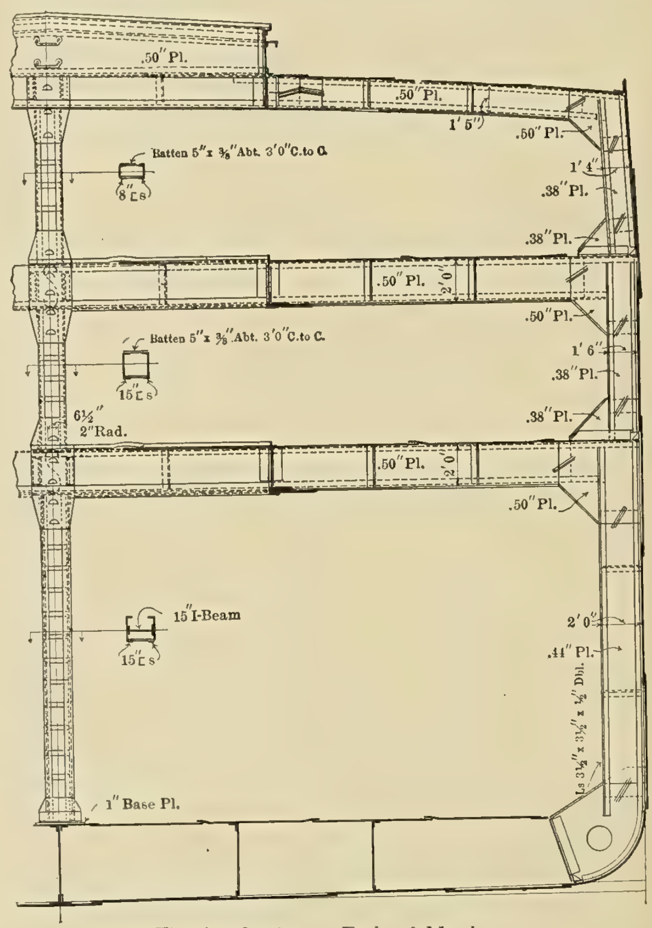


Fig. 1.—Section at Ends of Hatches

One circulating water pump for the lubricating oil system, 7 inches by 7 inches by 12 inches, of the vertical duplex double acting type.

Two oil coolers of 300 square feet cooling surface each.

One combination lubricating oil settling tank and filter with a filtering capacity of about 100 gallons per hour.

One feed and filter tank.

One fuel oil transfer pump, 8 inches by 8½ inches by 12 inches, vertical duplex double acting type.

Two fuel oil service pumps, 6 inches by 4 inches by 6 inches, of the horizontal duplex double acting type.

Two fuel oil heaters, each having the capacity to heat

10,500-TON DEADWEIGHT CARGO CARRIER

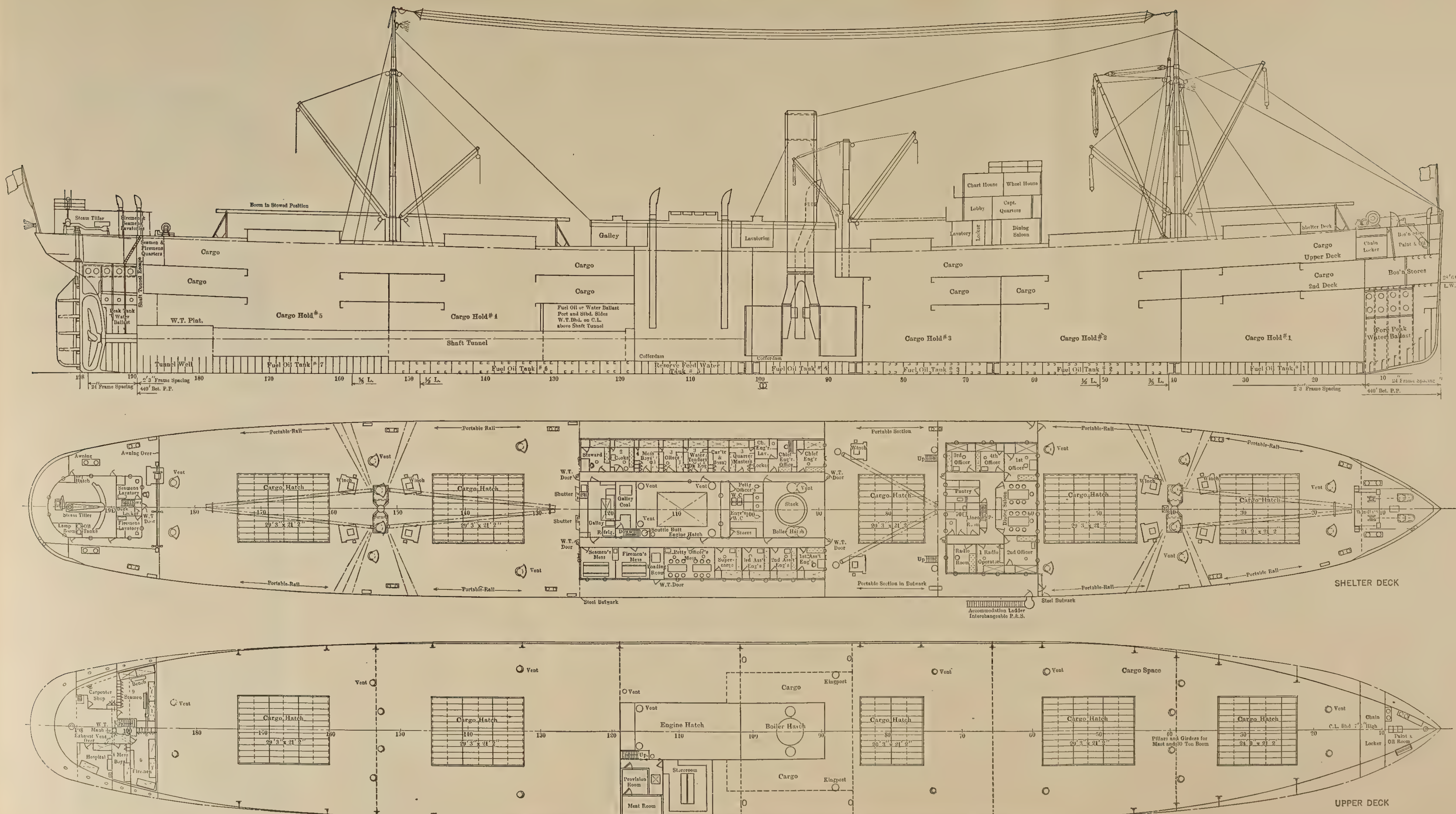


Fig. 2.—Inboard Profile and Deck Plans of Freighter for Shawmut Steamship Company: Length Overall, 457 Feet; Length Between Perpendiculars, 440 Feet; Beam, Molded, 57 Feet; Depth at Side to Shelter Deck, 39 Feet; Displacement at Designed Load Draft of 28 Feet 9 Inches, 15,000 Tons; Speed, 13 Knots

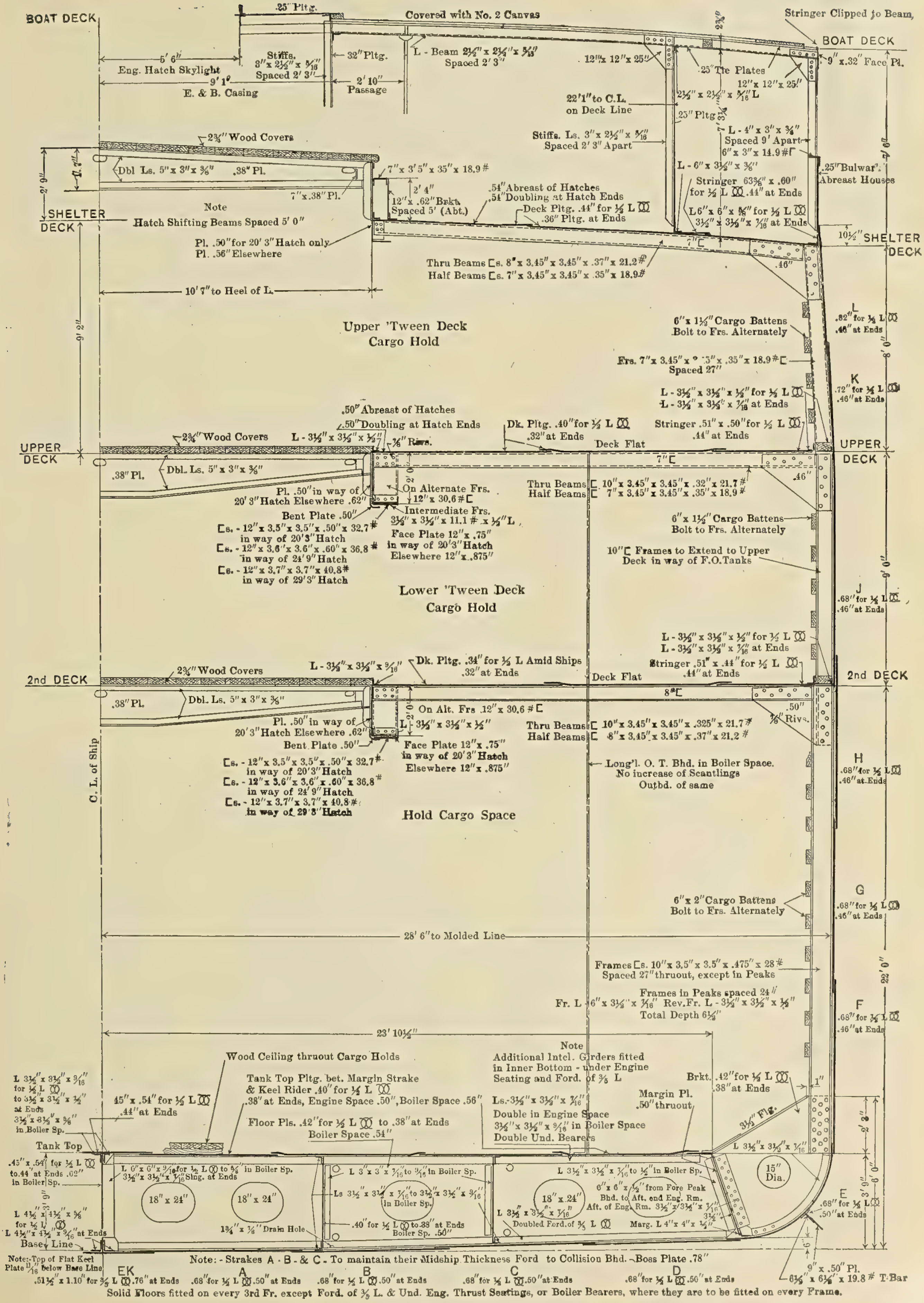


Fig. 3.—Midship Section

5,000 pounds of fuel oil per hour at 14 degrees Baumé from 90 to 250 degrees Fahrenhe

Two fuel oil strainers, one 2½-inch duplex basket type suction strainer and one 2-inch duplex basket type discharge strainer.

Two feed pumps, 12 inches by 8 inches by 26 inches, of the vertical simplex type.

inch cast iron brass fitted injector suitable for per square inch working pressure.

vater heater to have the capacity to heat 64,000 ter per hour from 90 to 215 degrees Fahren-

One evaporator feed pump, 4½ inches by 4 inches by 4 inch izontal duplex double acting type.

Two cast iron shell evaporators of the submerged tube type, each to have the capacity to evaporate 25 tons of water ev

One fresh water distiller to have a capacity of 2,000 gallons per

One auxiliary condenser of 800 square feet cooling surface, two pass, with shell and water heads of cast iron and fitted with the usual handholes, manholes, etc.

One fresh water pump, 5¼ inches by 4¾ inches by 5 inches, horizontal duplex double acting type.

One sanitary pump, 6 inches by 5¾ inches by 6 inches, of the horizontal duplex double acting type.

One fire and bilge pump, 10 inches by 8½ inches by 12 inches, of the vertical duplex double acting type.

One engine room bilge pump, 6 inches by 5¾ inches by 6 inches, of the horizontal duplex double acting type.

One fire and bilge hand pump, 6-inch by 5¼-inch single cylinder, double acting type, capable to lift 25 feet and discharge against a head of 100 feet.

One ballast pump, 10 inches by 12 inches by 12 inches, of the vertical duplex double acting type.

Boilers

Four single end Scotch boilers, 15 feet 10 inches internal diameter by 12 feet over the heads, will be installed to supply steam at 215 pounds per square inch working pressure. Each boiler has a total heating surface of 3,100 square feet and is provided with three furnaces having separate combustion chambers, which are fitted exclusively for oil burning. Forced draft will be provided by a blower having a capacity of 30,000 cubic feet of air per minute, driven by two single cylinder vertical engines.

A donkey boiler of sufficient size to furnish steam for starting fires in one main boiler is also provided.

Electric lights throughout the vessel will be supplied by two 10-kilowatt direct current generators.

Refrigeration for the cold storage rooms will be provided by a 2-ton refrigerating machine of the ammonia type.

Winches

Eight 8¼-inch by 10-inch and two 10-inch by 12-inch cargo winches will be located on the shelter deck in way of the cargo hatches. All cargo winches will be of the compound spur geared type having double horizontal reversible engines attached to the side housings.

One warping winch, 8¼ inches by 10 inches, single gear, fitted with two gypsy heads on an extension shaft and no drum will be located on the shelter deck aft.

Steering Gears

The main steering gear will be of the steam tiller type with a rack secured to the deck and double engines mounted on the tiller. The engines will drive through worm gearing to a pinion, which will engage the rack through a friction clutch. Steering control will be obtained by a hydraulic telemotor with polished brass controlling wheels and stands located in the pilot house and steering engine room aft.

An auxiliary hand steering gear, consisting of two large hardwood wheels with iron pedestal, is to be mounted on top of the after deck house. Power is transmitted by bevel gears, shafting, worm, worm wheel and pinion to a rack on a separate quadrant fitted to the rudder stock.

The windlass will be of the spur geared type with 10-inch by 10-inch horizontal reversible engines attached to the side housings, and having wildcats suitable for 2⅜-inch stud link chain. A warping shaft with a gypsy head on each end will be fitted on the after side of the windlass, clutches being provided to allow for independent operation of the windlass or gypsy. Hand operation is provided for by means of a ratchet arrangement fitted to the crank shaft.

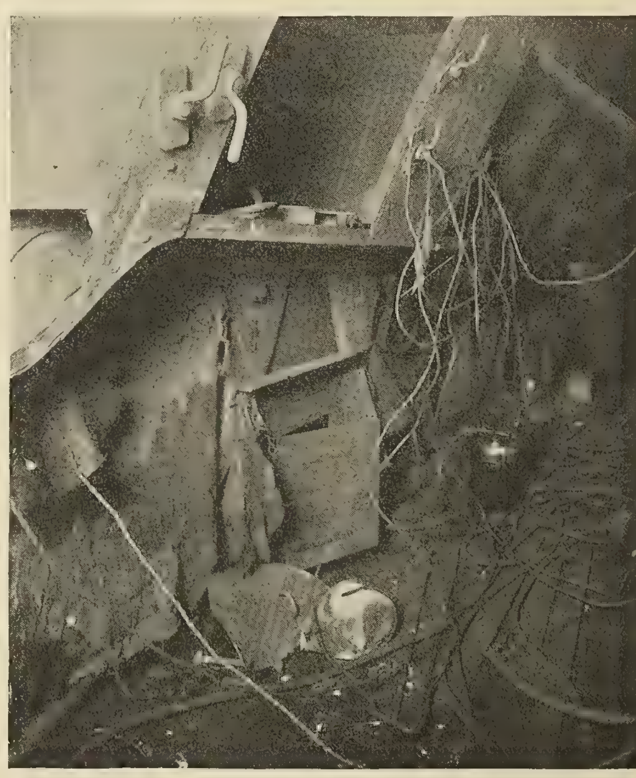
The propeller will be of the built up adjustable pitch type right hand screw, with four manganese bronze blades mounted on a cast iron hub and carried on a propeller shaft of 16¼ inches diameter.

These vessels are typical of the high class of vessels being added to America's merchant marine and will form a valuable addition to the fleet of the Shawmut Steamship Company.

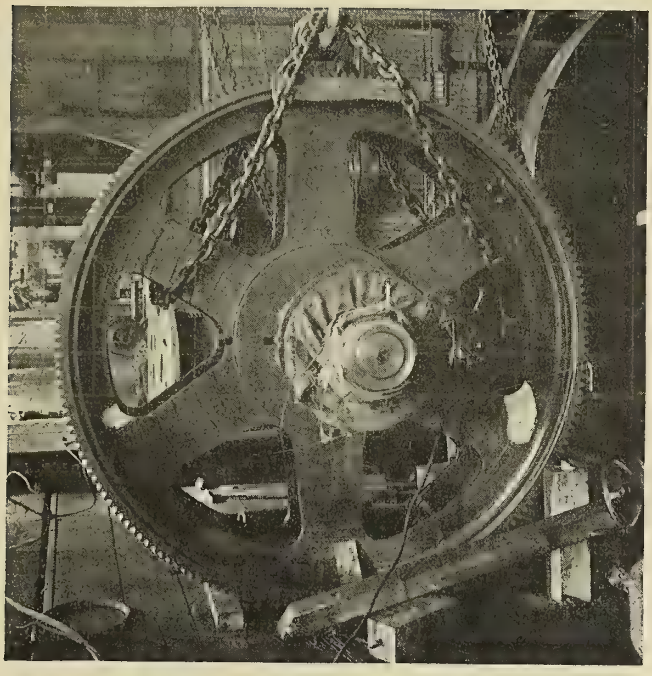
Electric Welding in Marine Repairs

NOT long ago the *Winnebago* came into port with three of her Scotch boilers burned out. Eight of the sheets in the back connections of the combustion chambers were in bad shape and required the insertion of patches, each of which was about 2 feet 6 inches wide and 3 feet high.

Welding a patch of this size in a flat surface is difficult at best, and, although it may seem strange, cold weather increases the difficulty. Although the drop in atmospheric temperature at the lowest point reached during the winter



Firing Aisle of the *Winnebago* While Boilers Were Being Repaired



Eight-Ton Herring-Bone Gear of the *Belfort* as it Finally Appeared After the Second Welding

is only slight in comparison with the temperature of the electric arc, it proves very troublesome in keeping the metal at a welding heat.

In making the repairs to the *Winnebago* a welding barge, having compressors and generators installed, was brought alongside the ship to supply air to the pneumatic chipping hammers and power to the "weldcraft" apparatus of the Electric Welding Company of America, who carried out the work. To overcome the effect of low temperature in the boiler space it was necessary to preheat the work considerably.

The welds as completed were of the multiple string type, having been commenced at the top of the patch, continued down along the sides, and the bottom closed last.

It was necessary to weld the calking edges of some of the plates and around several of the rivets to make the boilers tight again and fit for service.

Another instance of the application of the "weldcraft" process to marine work occurred in the welding of one of the 8-ton herring-bone gears of the *Belfort*. The wheel in question, which is 9½ feet in diameter with a 24-inch face, of double-flange and double-spoke construction, had been broken in several places and welded. The original welds did not hold, however, so that it was necessary to cut out all the metal deposited on the spokes and reweld the cracks. As a result of cutting away so much metal the final welds were rather large, but these have not proved to be defective since they have been returned to service.

Incidentally, this repair saved scrapping the gear.

Typical Multiple String-Type Weld, Particularly Adapted to Flue Sheet Repairs

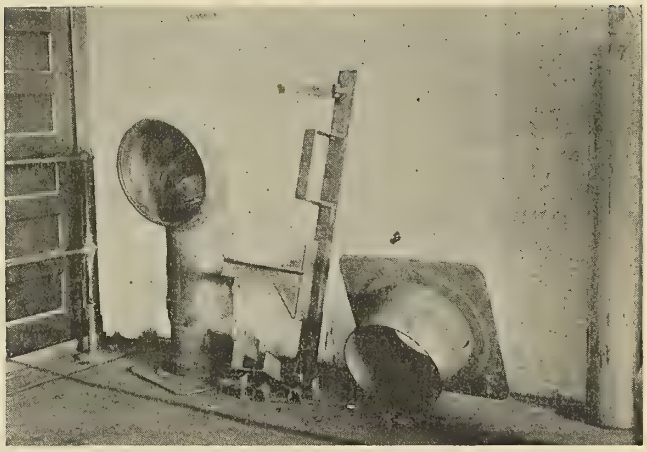


Fig. 1.—Left to Right: Portion of Welded Deck Rail Shown in Companion Picture; Welded Ventilator and Welded Ventilator Cowl, Ventilator Welded to Deck Plating; Welded Bulwark Splice; Combination Welds, Showing Welded-on Hinge, Pipe Hanger, Clip and Handle (Another Small Pipe Hanger Shown Below); Welded Deck Collar, Showing Welding at Deck Plate; Linde Oxygen Cylinder. All Welding by Oxy-Acetylene Process

Welded Joints on Ships

Low First Cost—Good Appearance—No Upkeep

GAS welding is more and more taking the place of riveting wherever metal joints are made. Especially is this so in shipbuilding where metal parts are exposed to salt air and moisture.

Every seafaring man knows how quickly a rim of rust will form along metal seams and around rivet heads even when painted. At such places the paint has to be gone over frequently because if it is neglected a rust scale will attack the metal and have to be scraped off by hand. Even landlubbers who go to sea know how common a sight is the ship's painter, with his little pot of red lead, eternally touching up crevices in the metal work, though this sight is not so familiar as it used to be. The reason is that many shipowners now have these troublesome joints reinforced by welding to make them weathertight and to better resist the vibrations and strains in the ships.

In new construction oxy-acetylene joints are recommended by representatives of the oxy-acetylene industries to take the place of riveted or combination riveted and welded joints, on the claim that they are both cheaper and stronger, besides being much neater in appearance. This

Fig. 2.—Left to Right: Ship's Ladder of Welded Construction by Oxy-Acetylene Process; Oxwelded Deck Rail, Welded to Deck Plating; Linde Oxygen Cylinder

was reluctantly admitted recently at the Marine Exposition in New York, when an old Scotchman, an expert riveter, who visited the Oxweld Acetylene Company's booth, questioned the economy of welding on a ventilator cowl that was exhibited. His lowest estimate of the cost of riveting was $40, as against a welding cost, inclusive of overhead, nearly 30 percent lower. Another skeptic questioned the strength of a welded deck rail. Accordingly, a test was made, the stanchion being pounded with a heavy sledge until it was bent at right angles without parting the weld. It was then placed in a forge and restored to its proper form, bending back without damage to the weld. The skeptic was thus converted.

The chief reason that welding has not been more generally applied in the building of ships heretofore is the fact that it is, in its present stage of development, comparatively new. Marine engineers and constructors are very properly conservative and cautious in the adoption of new departures to displace old established practices. The considerable list of permitted welding applications in ship construction and repair, as now authorized by the American Bureau of Shipping and the United States Steamboat Inspection Service, has come only after conclusive proofs in service tests establishing the fitness of welding in each particular instance. This list is being gradually extended.

Determining the Quenching Points in the Heat Treatment of Steel by Means of the Critical Temperature Chart

In developing various processes for heat-treating steel to impart certain qualities of hardness, toughness, tensile strength, grain structure and the like without changing the size or shape of the material, without the formation of scale or decarbonizing it, and with a minimum expenditure of labor, it has been found possible to utilize the known critical temperature record made by

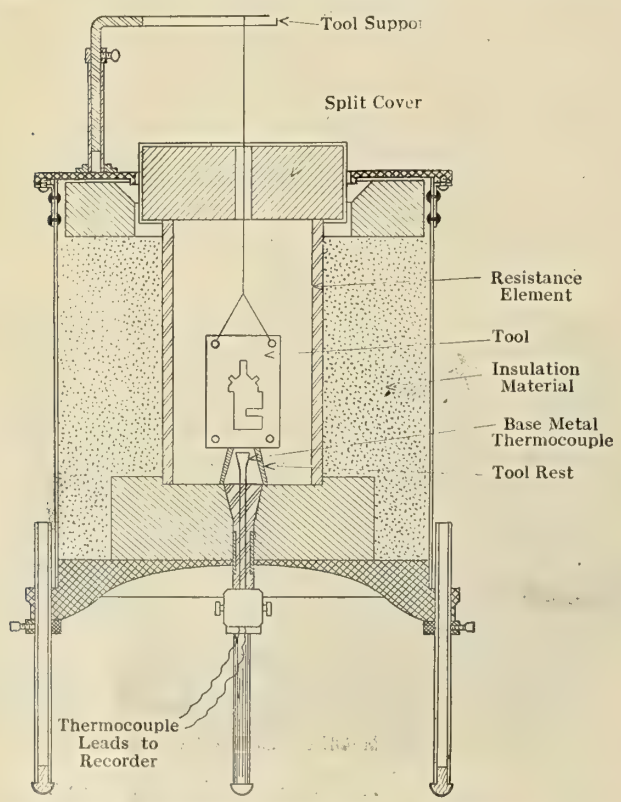


Fig. 1.—Leeds & Northrup Electric Furnace for the Heat Treatment of Tools and Dies by the Hump Method

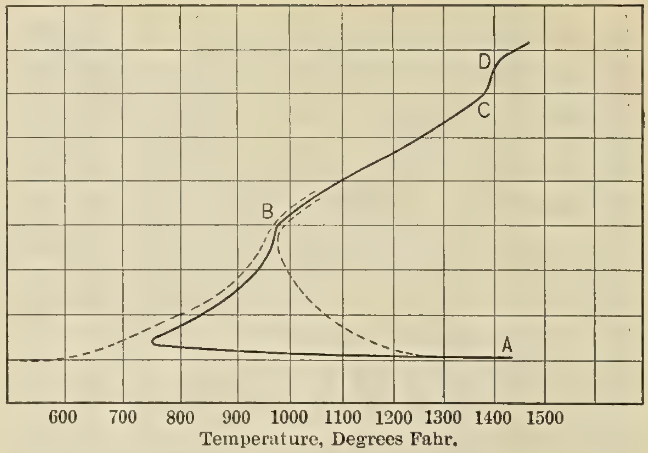


Fig. 2.—Curve Showing Temperature Changes in the Furnace and in the Tool

means of a suitable recording pyrometer to determine the proper quenching point. At the transformation or decalescence point a definite change of temperature occurs, and on a chart plotted from the temperatures of the steel, as drawn by the recording pyrometer, an offset or hump indicates the exact point of change. This fact has given the name of "hump method" to the heat-treating process recently developed by the Leeds & Northrup Company, Philadelphia, Pa.

Type of Furnace to be Used

The process may be carried out in an electric furnace similar to that shown in Fig. 1, in which the heating element consists of a vertical, cylindrical resistor surrounded by insulating material and a sheet iron jacket. The resistor rests upon a refractory block, which is supported by a cast iron bottom plate. A refractory cover is used to close the heating chamber at the top, while a cast iron top plate confines the loose insulating material filling the space between the resistor and the jacket. An iron-constantan thermocouple of bare No. 8 gage wire projects upwards from the center of the bottom refractory block. Covers are placed on the furnace so that the heating chamber is entirely inclosed, thus preventing the renewal of the atmosphere and protecting the work against oxidation and scaling.

The two instruments on which the value of the process depends are the thermocouple and a potentiometer of the curve drawing type, which gives a graphic record of the temperature of the thermocouple at all times. The slightest change in this temperature is properly indicated on the chart, and it is on this property that the efficiency of the method depends.

The Heating Process

The work to be treated is suspended by means of a wire from the tool support arm, Fig. 1, in such a manner that it practically rests on the thermocouple. At the moment when the work is introduced into the furnace the temperature of the latter may be, for example, about 1,400 degrees F., but the heat storage capacity of the furnace walls being small compared with that of the charge, the temperature of both thermocouple and furnace walls drops rapidly for a few hundred degrees, the current to the resistors being shut off during this time. Finally the temperature reaches a point of stability such as indicated by *B*, Fig. 2, to which temperature the charge has been heated. It is assumed that all parts of the furnace, thermocouple and charge are at temperature *B*, which is about 870 degrees F., and when the switch is closed and the temperature input regulated the rate of rise is constant.

The fact that all parts start from the same temperature at a point sufficiently far below the critical point, combined with the proper arrangement of the heating element with respect to the charge, insures, it is claimed, that all parts of the work will pass through the critical point simultaneously. This is desirable in order to avoid stresses and distortion that follow from unequal expansion or contraction.

When the work reaches the transformation point *C*, Fig. 2, an abrupt change occurs in the rate of heating, due to the increased capacity of the steel to store heat. When the transformation is completed at point *D*, the temperature again rises rapidly. The pause is clearly shown by the hump in the curve.

Quenching Point

Before quenching, it is necessary to heat the work to a certain distance above, or for a certain time after, this point, the time or distance depending upon the mass and shape of the steel, the quenching medium employed and the qualities desired. The exact point for different materials must first be determined by experience or trial. The hump on the curve is used as a reference point, and by means of it a number of variables which occur in the present methods of heating are controlled.

In properly heating tools, such as punches or dies, a knowledge of certain variable elements must be known at all times. The point above the critical temperature at which the tool is to be quenched determines the property which the tool will have when it is removed from the quenching medium. The exact temperature, therefore, for quenching to impart a certain degree of hardness or a certain normal growth of grain, is very essential.

Rate of Heating Controlled

If a tool is heated too fast, stresses are set up in the structure which will cause deformation and, possibly, breakage when placed in service. Slow heating will cause a change in the volume of the steel which entails a refinishing operation to bring it to the correct size. The potentiometer record eliminates both the fast and the slow heating possibilities.

Another point that is to be considered in treating steel is the necessity of preventing a change of atmosphere in the furnace. Any additional supply of oxygen after the heating has once been started causes scaling or decarbonization.

Quenching conditions are readily controllable once the critical temperature is known and the accuracy of the ordinary pyrometer is not depended upon for this temperature, the transformation being indicated by the hump on the curve.

All of the problems of hardening are by no means eliminated by the use of the "hump method," but the treatment seems to be more nearly under the control of the operator than in any other method so far developed.

A New Cable Steamer

THE Fairfield Shipbuilding & Engineering Company, Limited, Govan, England, launched on May 29 the twin screw steamer *Lady Denison-Pender,* which has been built to the order of The Eastern Telegraph Company, Limited, London.

The vessel will be employed in the laying and repairing of telegraph cables. She is of the shelter deck type, with a long bridge and cruiser stern, 282 feet 8 inches by 38 feet 0 inches by 25 feet 0 inches depth to shelter deck, and 1,900 tons carrying capacity at a draft of 17 feet 6 inches, with a speed of 12 knots. There is accommodation for a total complement of 100, with hospital, surgery and cable testing rooms, a refrigerating chamber, a large chart room and the usual workshops and store rooms, the ventilation of which has received special consideration in view of long periods in a tropical climate. The ship is rigged as a two-masted schooner with two 5-ton derricks on the fore mast, and will be fitted with Marconi's latest system of wireless equipment.

There are three cable tanks having a total capacity of 20,830 cubic feet, which is equal to 600 nautical miles of cable. There are two sets of the latest type of cable working machinery with bow sheaves of an improved pattern.

The propelling machinery consists of two sets of three crank triple expansion engines with cylinders 15½ inches, 25 inches and 41 inches in diameter and 2 feet 6 inches stroke, supplied with steam by three single ended cylindrical boilers fitted with Howden's system of forced draft.

Launching of New Cable Steamer *Lady Denison-Pender*

Ventilating Systems

A Graphic Method of Determining the Sizes of Mains and Ducts for Mechanical Ventilation

BY COMMANDER G. A. BISSET, CONSTRUCTION CORPS, U. S. N.

THE calculations outlined below are based on the General Specifications of the United States Navy, using a coefficient of friction for ordinary piping of .0001.

Certain standard conditions are assumed when determining the sizes of pipes, among which are the following:

A mean velocity over the area of the pipe of not less than 2,000 feet per minute, nor greater than 2,200 feet per minute.

The total head developed by the fan to correspond to a head of 2.2 inches of water or a pressure of 11.44 pounds per square foot.

The above conditions are for air with barometric pressure of 30 inches of mercury, a temperature of 70 degrees Fahrenheit and a relative humidity of 70 percent. Under these standard conditions a cubic foot of air weighs 0.07465 pound.

Losses

The total head available at any point in a main is equal to the total head developed by the fan minus the losses in the inlet and discharge piping of the fan up to that point. These losses usually consist of the following:

Loss due to friction of piping.
Loss due to elbows.
Loss due to converging tapers in piping.
Loss due to wire mesh on inlet cowl.

(The last loss is negligible and is omitted where the size of the mesh is approximately 1½ inches by 2 inches.)

Diagrams

By the proper use of the diagrams shown in Figs. 1 and 3, the calculations for vent piping are greatly simplified.

Loss due to friction of piping is obtained directly from Fig. 1, as follows:

Find the intersection of a diagonal line representing the diameter of pipe and the ordinate for air delivery in cubic feet per minute. The abscissa passing through this intersection gives the friction loss, per foot of pipe, in inches of water as indicated on the scale at the left.

In order to simplify the calculations of losses in elbows and to cover losses in bends of less than 90 degrees, the following table of losses has been prepared. The equivalent lengths of pipe given in the table are to be added to the length of pipe of the same size, including the length of the elbows measured on the centerline.

TABLE 1

Equivalent lengths of pipe for losses due to bends. Add to length of pipe of same size, including bends or elbows, for each bend or elbow.

Bend (Degrees)	Round Pipe. Equivalent Length in Feet
10	.65 *d*
20	1.31 *d*
30	1.97 *d*
40	2.63 *d*
45	2.95 *d*
50	3.28 *d*
60	3.94 *d*
70	4.60 *d*
80	5.25 *d*
90	5.91 *d*

Where d = diameter of round pipe in feet.

The loss of head due to converging cones in piping is taken as the mean friction loss of the tapered section, i. e., the length of the taper or cone times the mean of the friction loss per foot of pipe, at the beginning and end of the cone, for the same volume of air in the piping. The friction loss per foot of pipe for various volumes of air is found from the diagram.

Where the pipe is not round, Fig. 1 is used to determine the equivalent size of round pipe for the same loss per foot before using the above table. This is done by finding the point on diagram Fig. 1, where lines corresponding with the width and height of rectangular pipe intersect. From the intersection project a line horizontally till it meets one of the lines labeled $\sqrt{\frac{A^3}{S}}$, which will give the size of round pipe for equivalent loss. For example, if we have a rectangular pipe 8 inches by 16 inches, we find that size of round pipe for equal loss is 12¼ inches diameter.

Fig. 3 is used to determine the sizes of branches as hereinafter described.

Typical Example

The value of the diagrams to those having ventilation systems to design or check is illustrated by the following:

Assume a ventilating system as indicated in Fig. 2. The system consists of the inlet piping, a 4,000 cubic foot ventilating set with inlet and outlet dimensions as shown, a main, and eleven branches with a total delivery of 4,000 cubic feet per minute.

The losses in the inlet piping and main are found as follows:

(a) Loss in cowl A and mesh in inlet is neglected.

(b) Loss in cone B may be found from the diagram, Fig. 1, as follows:

Find the intersection of the vertical line, corresponding to a delivery of 4,000 cubic feet of air per minute, with the diagonal line for a pipe 29 inches in diameter. The horizontal line through the point of intersection corresponds to a loss of .0005 inch of water per foot of pipe, which is found at the left hand side of the diagram. The loss per foot of 21¼-inch diameter pipe for the same volume of air is found in the same manner and is .0024 inch. The length of the cone is 57 inches, or 4.75 feet, and the loss is

$$4.75 \times \frac{.0005 + .0024}{2} = .0069 \text{ inch.}$$

The total length of section C measured on the centerline is 19.7 feet, including two 90-degree elbows and a 30-degree bend.

From Table 1 above, the equivalent length of pipe for a 90-degree elbow is found to be 5.91 diameters, or 11.82 diameters for two elbows, and for a 30-degree bend 1.97 diameters. The equivalent length of pipe to be added is then

$$(11.82 + 1.97) \times \frac{21.25}{12} = 24.4 \text{ feet.}$$

The loss per foot of 21¼-inch pipe is .0024 inch of water, found as above, and the total loss in section C is .0024-inch (19.7 + 24.4) = .1058 inch.

Friction Loss, Per Foot of Pipe, in Inches of Water.

VENTILATING SYSTEMS

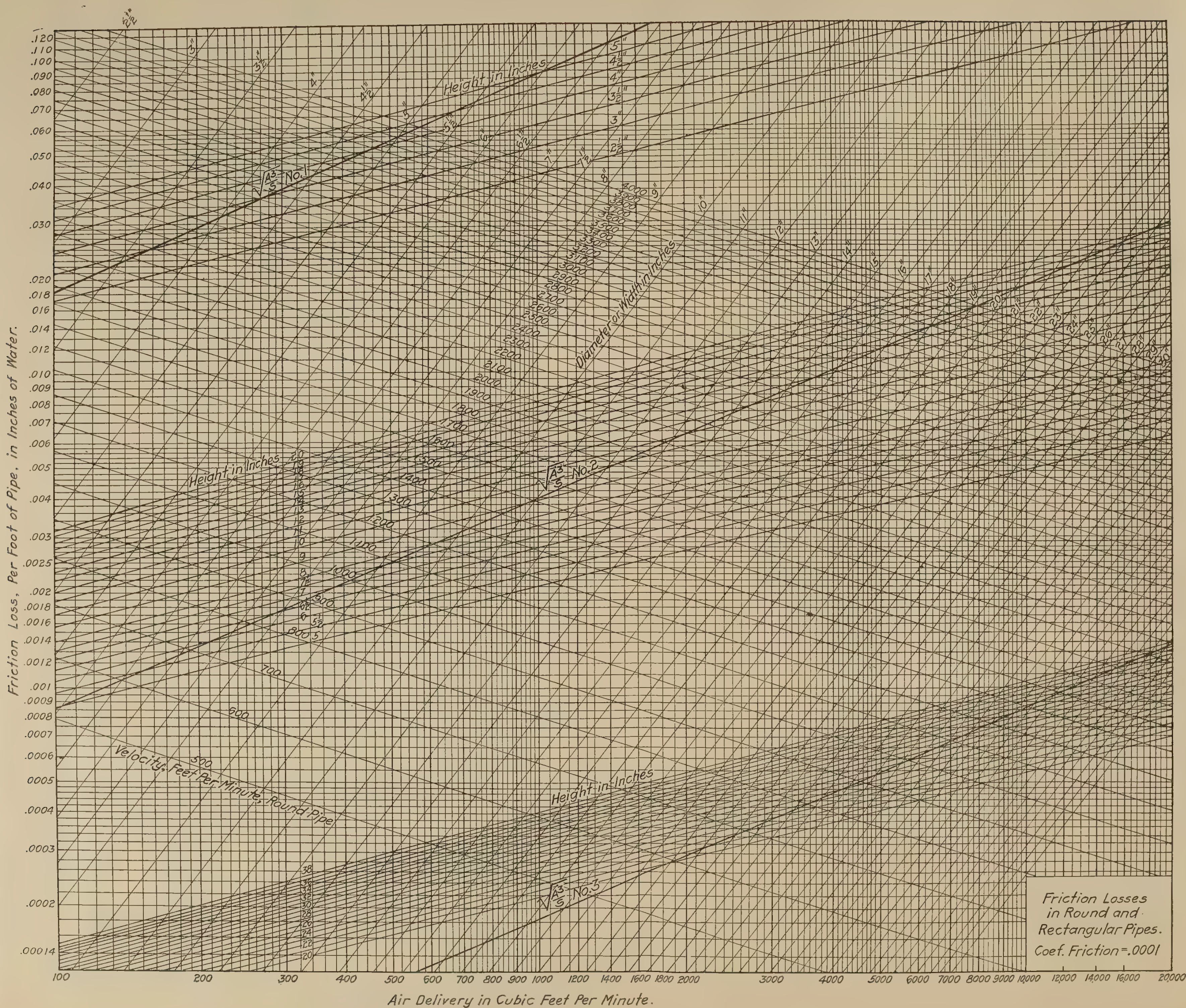


Fig. 1

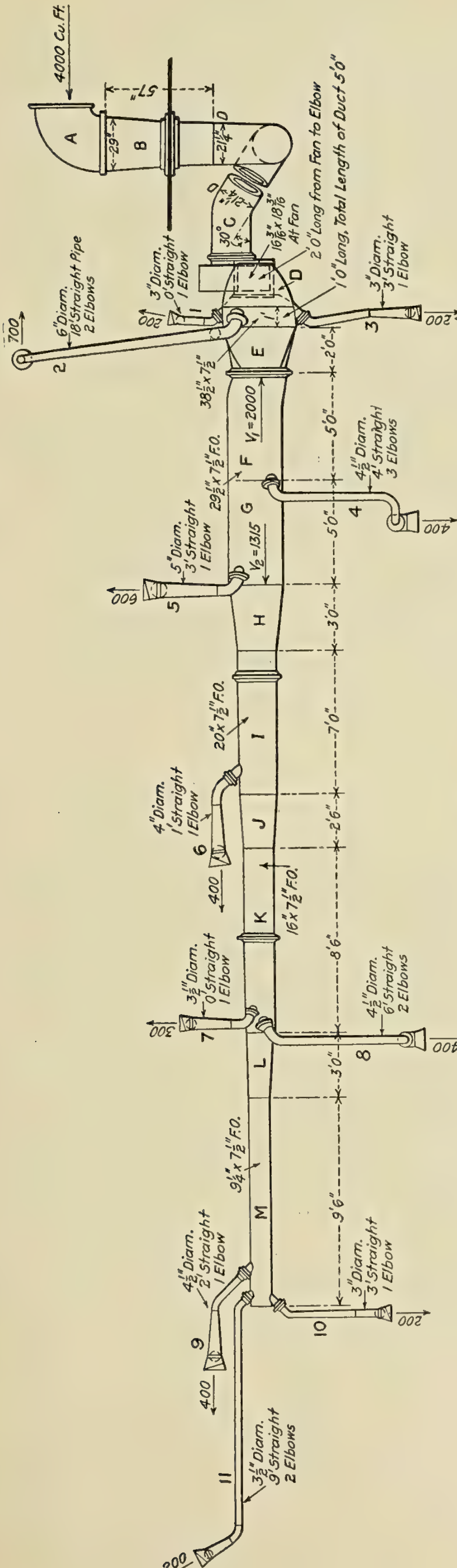


Fig. 2

Section D includes 2 feet of 16 3/16-inch by 18 3/16-inch pipe, an elbow 16 3/16 inches by 18 3/16 inches at one end and 38½ inches by 7½ inches at the other end, and 1 foot of 38½-inch by 7½-inch pipe. The loss per foot of 16 3/16-inch by 18 3/16-inch pipe for delivery of 4,000 cubic feet per minute is found as follows:

On the diagram, Fig. 1, find the intersection of diagonal lines for a width of 18 3/16 inches and a height of 16 3/16 inches. A horizontal line should be drawn through this point until it intersects one of the lines labeled $\sqrt{\frac{A^3}{S}}$. The intersection of the above horizontal line with the diagonal line for $\sqrt{\frac{A^3}{S}}$ shows the diameter of a round pipe which will have the same loss of head per foot as the rectangular pipe for the same volume of air. In this case the diameter of the equivalent round pipe is approximately 18.8 inches. The intersection of a diagonal line for this diameter with the vertical line for a volume of 4,000 cubic feet indicates a loss per foot of .0043 inch at the left hand side of the diagram. The loss per foot of 38½-inch by 7½-inch pipe is found in the same manner as above, except that, as this ratio of width to height of pipe is unusual, it is necessary to project the diagonal lines for these dimensions beyond the limits of the diagram. The equivalent round pipe is found to be 17½ inches in diameter, for which the loss per foot is .0063 inch at a volume of 4,000 cubic feet.

The loss in the 16 3/16-inch section is $2 \times .0043 = 0.0086$ inch.

The loss in the 38½-inch by 7½-inch section is $1 \times .0063 = .0063$ inch.

The loss per foot of straight line pipe which has a similar change in shape to that of the elbow will be the mean of the loss per foot for each size pipe, or

$$\frac{.0043 + .0063 \text{ inch}}{2} = .0053 \text{ inch.}$$

The equivalent length for loss due to bend, to be added to the length of the elbow measured on the centerline, is found by getting the equivalent round pipe (for a loss of .0053 inch per foot at 4,000 cubic feet delivery) and multiplying by the coefficient as given in Table 1.

Equivalent round pipe is 18 inches or 1.5 feet diameter. Equivalent length straight pipe is $5.91 \times 1.5 = 8.9$ feet.

Assume the length of the elbow on the centerline to be 4 feet. Then the loss in the elbow will be $(4 + 8.9) \times .0053 = .0684$ inch. Total loss in D is then $.0086 + .0063 + .0684 = .0833$.

Section E is 2 feet long, and the loss in head is the mean of the loss per foot of 38½-inch by 7½-inch and 29½-inch by 7½-inch pipe for 2,900 cubic feet times the length of E. The losses per foot of pipe are found from the diagram as outlined above, using the new dimensions and volume. The loss per foot of 38½-inch by 7½-inch pipe for 2,900 cubic feet is .0033 inch, and of 29½-inch by 7½-inch pipe for 2,900 cubic feet is .0058 inch. The loss in E is then

$$2 \times \frac{(.0033 + .0058)}{2} = .0091 \text{ inch.}$$

The loss in F is the loss per foot of 29½-inch by 7½-inch pipe for 2,900 cubic feet times the length plus the equivalent length for the offset. Assume the offset to consist of two 10-degree bends, then the equivalent length of pipe to be added is found as follows:

A 29½-inch by 7½-inch pipe is equivalent in loss to a 15.6-inch diameter round pipe from Fig. 1. Using Table 1:

Equivalent length straight pipe = 1.30 × 15.6/12 = 1.7 feet.

a Branch Number	b Delivery, Cubic Feet per Minute	c Length Straight Pipe (Feet)	d Number of Elbows
1	200	0	1
2	700	18	2
3	200	3	1
4	400	4	3
5	600	3	1
6	400	1	1
7	300	0	1
8	400	6	2
9	400	2	1
10	200	3	1
11	200	9	2

The loss in F is then .0058 (5 + 1.7) = 0.039 inch.

The loss in G is found in the same manner as for F, except that the volume used will be 2,500 cubic feet and no offset is considered.

The losses in the remaining sections are found as outlined above. The work may further be simplified by first finding the losses per foot and total losses in the sections of each size for the proper volume and then with the losses per foot of each size pipe calculating the losses in the cone between the sections. This simplifies the work without affecting the results.

In tabular form the losses in the main and inlet piping will be as follows:

Volume of Air, Cubic Feet	Loss
(A) 4,000	Loss of head neglected
(B) 4,000	$\frac{(.0005 + .0024)}{2} \times 4.75 = .0069$ inch
(C) 4,000	.0024 (19.7 + 24.4) = .1058 inch
(D) 4,000	$(2 \times .0043) + (1 \times .0063) + \frac{(.0043 + .0063)}{2} \times (4 + 8.9) =$ .0833 inch
(E) 2,900	$\frac{(.0033 + .0058)}{2} \times 2 = .0091$ inch
(F) 2,900	.0058 (5 + 1.7) = .0390 inch
(G) 2,500	.0043 × 5 = .0215 inch
(H) 1,900	$\frac{(.0025 + .0059)}{2} \times 3 = .0126$ inch
(I) 1,900	.0059 × 7 = .0413 inch
(J) 1,500	$\frac{(.0037 + .0061)}{2} \times 2.5 = .0123$ inch
(K) 1,500	.0061 × 8.5 = .0519 inch
(L) 800	$\frac{(.00175 + .0064)}{2} \times 3 = .0122$ inch
(M) 800	.0064 × 9.5 = .0608 inch

If heating or cooling coils are included in the system the loss in pressure due to these coils should be considered in connection with the friction losses in piping and added thereto. The Sturtevant heaters used extensively on naval vessels have a resistance at rated volume, when by-passed, of approximately ½ inch of water, and when the air is passing through the heater of approximately 1 inch. When the volume of air passing through the heater is 30 percent less than the specified volume, as permitted under certain conditions, the resistance is reduced to approximately ½ inch.

Branches

The branches of the system are as follows:

e Angle of Branch (Degrees)	f Available Head at Branch (hu)	g $\sqrt{\frac{hu}{2.2}}$	h Delivery to Be Used on Fig. 3 b/g
30	2.0040"	.954	210
30	2.0040"	.954	734
30	2.0040"	.954	210
30	1.9559"	.943	424
30	1.9344"	.937	640
30	1.8805"	.924	433
30	1.8163"	.908	330
30	1.8163"	.908	441
30	1.7433"	.891	449
30	1.7433"	.891	224
30	1.7433"	.891	224

The available head at branch (hu) is found by subtracting losses in piping from pressure developed by fan (2.2 inches the standard total head).

In calculating the losses in branches, the net gain in static head due to coning the outlets so as to reduce the velocity may be combined with the loss due to ½-inch wire mesh on the outlet of the cone as follows:

Take d_1 as the diameter of the branch and d as the diameter of outlet of the cone. The net gain due to coning the outlet is equivalent to reducing the length of the branch by $27.2\left(L - \frac{d_1^4}{d^4}\right)$ diameters. The loss due to ½-inch wire mesh on the outlet is equivalent to increasing the length of the branch by $14.7 \frac{d_1^4}{d^4}$ diameters. Hence:

$$27.2\left(L - \frac{d_1^4}{d^4}\right) - 14.7\frac{d_1^4}{d^4} =$$

decrease in length of branch due to combined effect with cone taper 1½ inches per foot. This formula gives a net gain in static pressure equivalent to decreasing the length of branch if the diameter of the outlet of the cone is more than 12 percent greater than the diameter of the branch. As this will usually be the case, and in order to give a small factor of safety as to delivery the effect of the cone and wire mesh may be neglected. The loss due to each elbow is equivalent to 8.3 diameters for round pipe. This loss is added to the length of straight pipe. If desired, the losses given in Table 1 may be used and added to the length of pipe of same size including elbows. The loss due to entrance is equivalent to 8.3 diameters for a 30-degree branch of round pipe.

The losses in the branches in equivalent lengths of straight pipe are as follows, based on the number of elbows and angle of branch given in a previous paragraph:

Branch Number	Loss Due to Elbow	Loss Due to Entrance	Total Loss Due to Elbows and Entrance to Branch
1	$8.3d_1$	$8.3d_1$	$16.6d_1$
2	$16.6d_1$	$8.3d_1$	$24.9d_1$
3	$8.3d_1$	$8.3d_1$	$16.6d_1$
4	$24.9d_1$	$8.3d_1$	$33.2d_1$
5	$8.3d_1$	$8.3d_1$	$16.6d_1$
6	$8.3d_1$	$8.3d_1$	$16.6d_1$
7	$8.3d_1$	$8.3d_1$	$16.6d_1$
8	$16.6d_1$	$8.3d_1$	$24.9d_1$
9	$8.3d_1$	$8.3d_1$	$16.6d_1$
10	$8.3d_1$	$8.3d_1$	$16.6d_1$
11	$16.6d_1$	$8.3d_1$	$24.9d_1$

The diameter of any branch may be found as outlined below for branch No. 2. For a trial diameter find from the diagram, Fig. 3, the diameter of a branch 18 feet long

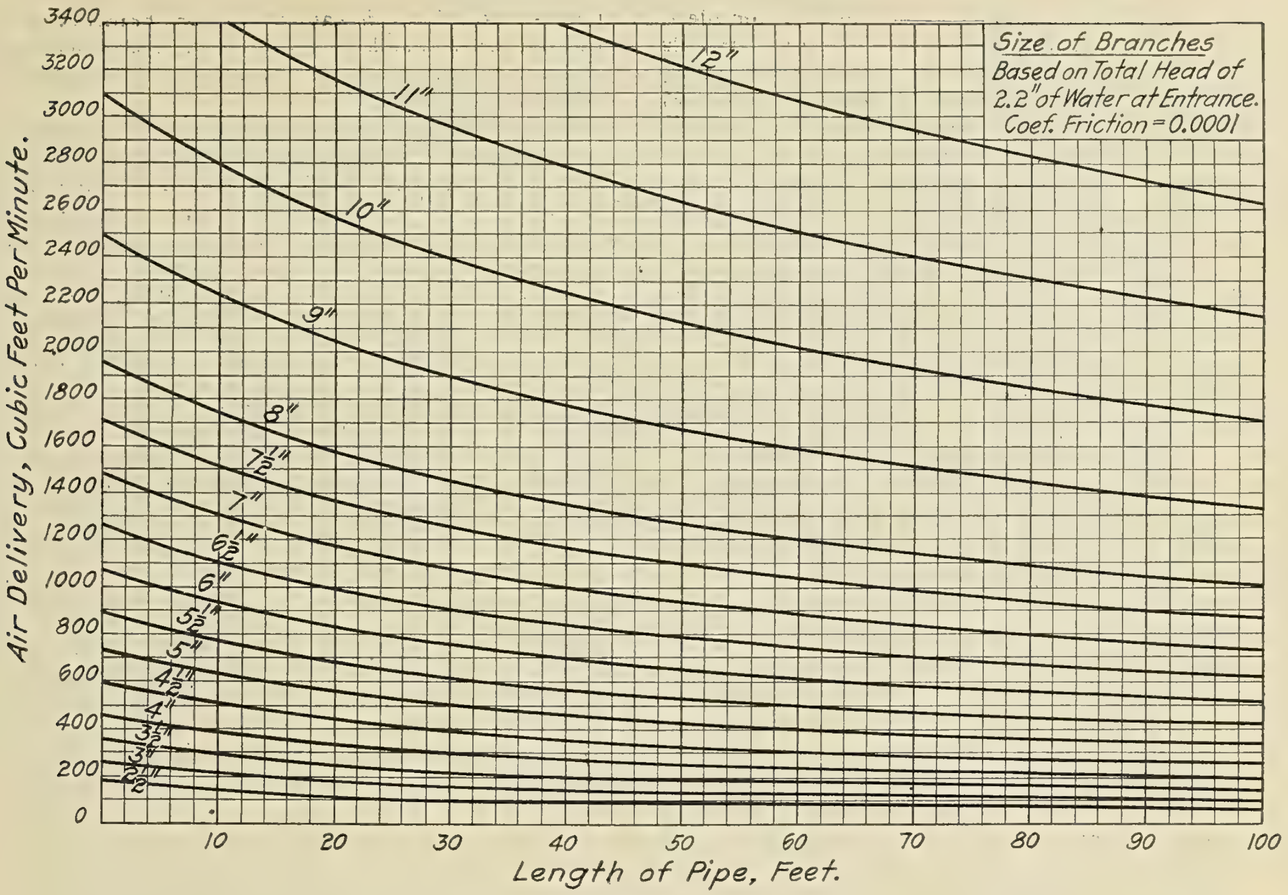


Fig. 3

which will deliver 734 cubic feet of air per minute. The diameter is 6 inches. The loss due to elbows and entrance to branch is equivalent to a length of pipe equal to $24.9d_1$. This corresponds to 12.45 feet of 6-inch pipe. The total length of branch to be used in finding the diameter from the diagram is 30.45 feet. For a delivery of 734 cubic feet per minute this length is found between the curves for 5½ and 6-inch branches; 6-inch is therefore the proper size to use. If the net gain in static pressure due to the cone were considered, it would approximately compensate for the losses due to elbows and entrance to branch so that the diameter indicated would be about 5½ inches. To find the diameter for outlet of cone for this branch, assume that the desired air velocity at the outlet of the branch is 1,000 feet per minute. A cone of sufficient diameter to deliver the required volume at this velocity should be fitted to the branch. If standard ½-inch wire mesh is fitted to the cone, the diameter of the cone should be sufficient to compensate for the restricted area due to the wire mesh. Take the reduction in area due to ½-inch mesh of 0.62-inch diameter wire to be 23 percent. Then to find the diameter of the outlet of the cone from diagram, Fig. 1, divide the required volume by the effective area (77 percent) and find the diameter of pipe for this volume at the required velocity. For branch No. 2 $\frac{700}{.77}$ = 910 cubic feet.

The diameter of pipe from the diagram corresponding to this volume at 1,000 feet per minute is approximately 13 inches.

The diameter of the other branches may be found in a similar manner, and will be as follows, neglecting the gain in pressure due to outlet cones:

Branch Number	Diameter of Branch (Inches)	Diameter of Outlet Cone for 1,000 Feet per Minute (Inches)
1	3	7
2	6	13
3	3	7
4	4½	9¾
5	5	12
6	4	9¾
7	3½	8½
8	4½	8½
9	4½	9¾
10	3	7
11	3½	7

If any system or branch supplies a space which may be under pressure, whether designed or due to inadequate facilities for escape of air, or if a system or branch exhausts from a space which may have a low pressure due to inadequate air supply, the difference between this high or low pressure and atmospheric pressure should be estimated in inches of water and treated as a loss of head. This loss of head may be handled in two ways. The available head (hu) at the inlet of the branch may be reduced by the amount of this loss before calculating the quantity of air to use in finding the size of branch from diagram, Fig. 3, or the loss may be reduced to the equivalent length of branch in feet by finding the loss of head per foot at the specified delivery for the trial diameter of branch and dividing this loss per foot into the loss due to pressure difference, this equivalent length to be added to the length of branch for finding the proper diameter. If a system or branch supplies a space having a low pressure or exhausts from a space having a high pressure, the difference between the high or low pressure and atmospheric pressure should be treated as a gain of head. In the case of a space with both supply and exhaust ventilating systems, the gain in head for the supply systems may be considered as the difference between atmospheric pressure and the low pressure due to exhaust systems if the supply systems were not in operation, and the gain in head for the exhaust systems as the difference between atmospheric pressure and the high pressure, due to the supply systems, if the exhaust systems were not in operation. Volumetric tests of such systems are to be made and the systems should be so designed as to deliver the specified volume of air without the aid of the gain in head produced by either supply or exhaust systems. The additional air supplied by any such system with both supply and exhaust systems in operation may be estimated by calculating the increased delivery due to the gain in head.

Ventilation Piping and Details
Design Points

The following information covers points of importance in the actual design of piping and details.

The terminal velocities, as required by the Navy Department, are as follows:

Sick bay	500 feet per minute
Central and substations	800 feet per minute
Quarters and living spaces	1,000 feet per minute
Other places	1,500 feet per minute

All exhaust ventilation branch intakes should be designed to provide double the area which would be required for supply outlets of corresponding capacity.

It has not been found necessary to provide terminals with dampers, except in quarters and living spaces. In storerooms, passages, etc., no dampers are necessary and the terminals themselves need not have the adjustable features of the terminals in quarters.

All exhaust terminals should be provided with dampers and wire mesh guards.

Terminals in magazines (both powder and shell spaces) should be provided with wire mesh guards.

When a main subdivides into two branches of unequal size and resistance, it is well to provide an adjustable damper to aid in the subdivision of the air.

Branches should lead off from mains at an angle of about 30 degrees. This should be increased toward the ends of the mains, however, to 45 degrees where two branches lead off, or, in case of only one branch at end of main, the angle should be 90 degrees and the end of the main blanked off. The next to last branch might then well be made 45 degrees.

Where ventilation ducts pierce a watertight compartment, without delivering air to such compartment, the pipe should be constructed watertight. Such pipes, 6 inches and under, should be standard steel pipe; above 6 inches, the pipes should be made of 5-pound steel plate, lap-welded or riveted watertight.

Non-watertight ducts and pipes should be constructed of sheet steel galvanized and of the following thicknesses:

Size of Pipe (Diameter or Long Side)	Mils	U. S. Gage
6 inches and less	31	22
Above 6 inches and including 10 inches	37	20
Above 10 inches and including 12 inches	50	18
Above 12 inches	62	16

Portable sections and watertight covers should be provided wherever non-watertight ducts pierce watertight decks or bulkheads, also where watertight ducts terminate in a watertight compartment.

All branches supplying air to compartments below the lowest complete watertight deck should be watertight from that deck to the compartment supplied. This is to prevent the flooding of any compartment from another. Separate supply and exhaust ducts should be run for each compartment regardless of the additional holes through decks. Such supply and exhaust ducts may unite into a common pipe above the lowest complete watertight deck, however.

The radius to the center of pipe for all bends and elbows should be equal to 1½ diameters for round pipe and 1½ times the width, in the direction of radius, for square and rectangular pipe.

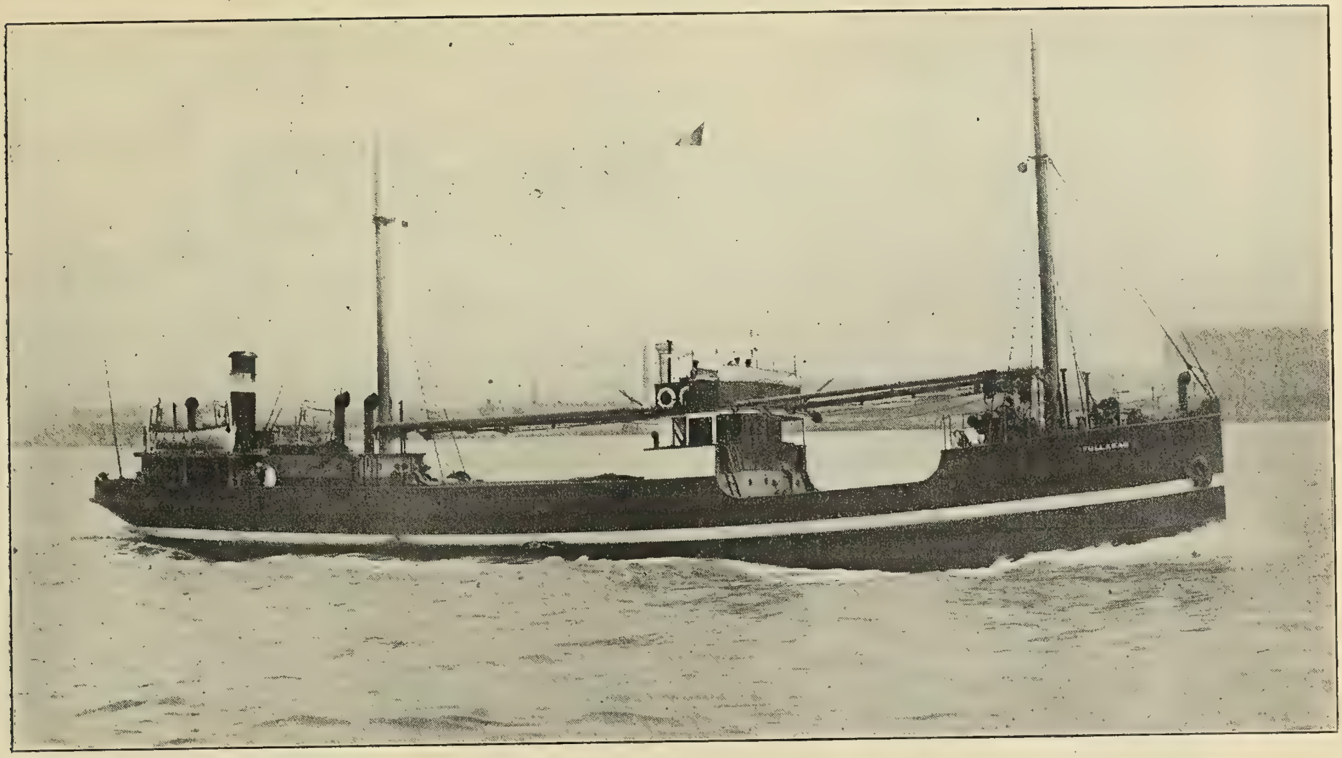
As the branches lead off, the size of a main should not be changed until sufficient air has been removed to reduce the velocity to a value between 1,200 and 1,500 feet per minute; then the main should be contracted with a taper of 1½ inches to the foot for round or square pipe or the equivalent for rectangular pipe until the area is so reduced that the velocity again reaches 2,000 to 2,200 feet per minute. The contraction should be made wherever necessary, but the final area of the main should be not less than four times the area of the last branch.

Welded Motorship Fullagar

The welded motorship Fullagar recently built by Cammell Laird & Company, Ltd., Birkenhead, England, is unique not only because of the fact that not a single rivet has been used in its construction, the hull being welded throughout, as are also the fuel, lubricating and water tanks, but also because it is the first vessel to be fitted with the Cammellaird-Fullagar type of main oil engine.

FOR many years, various processes of electric welding have been in use for effecting repairs in certain parts of boilers and in a few parts of the hulls of ships. It was always considered, however, that such welding was not to be relied upon in parts of a ship subjected to very heavy stresses. In the meantime, a new process of electric welding was devised, known as the Quasi-Arc system, which was used by Cammell Laird & Company, Ltd., on a battleship which had developed a serious fracture in her stern frame. The damaged casting was welded, and afterwards very severely tested at sea, with results so satisfactory that Cammell Laird & Company decided to experiment further with the new system of welding. Concerted action was taken by the shipbuilders and Lloyd's Register of Shipping, and after careful deliberation a series of tests was arranged to decide as far as possible on a small scale whether welded joints could be relied upon to replace riveting in a ship.

In the first place, the technical side of the problem only was dealt with, and in addition to obtaining information on tensile strength, the elastic properties of the welded metal, as well as its resistances to a continuous reversal of stresses, were investigated. In addition, chemical and microscopical tests were made. As a result, Lloyd's Register of Shipping gave its approval to the Quasi-Arc electric welding, and a set of rules for its application



Welded Motorship *Fullagar* Fitted With "Camellaird-Fullagar" Oil Engine Built by Cammell, Laird & Company, Ltd., Birkenhead, England

is now embodied in the ordinary rules of this society.

Experimental tests, however well devised, cannot be as good as actual experience under working conditions. The next obvious step, therefore, was to build a welded ship. This required courage and faith, in spite of the satisfactory tests on a small scale. There were many things to be thought of, apart from the technical possibilities of welding. The ordinary type of riveted joint was not necessarily the best for welding work, so that special consideration had to be given to these. The problems of assembly and erection were altogether new. Men had to be trained as welders, and, of course, a new plant was necessary.

The first vessel to be built in accordance with this system of welding was the motorship *Fullagar,* which has the following molded dimensions:

Length	150 feet
Beam	23 feet 9 inches
Depth to main deck	11 feet 6 inches
Height of raised quarterdeck	4 feet
Draft	11 feet 4 inches
Deadweight capacity (about)	500 tons
Cargo capacity (about)	25,200 cubic feet
Brake horsepower (about)	450
Speed (about)	9½ knots

For carrying the cargo the vessel has one long hold served by two hatches. The propelling machinery is located aft with the fuel oil carried in side bunkers above the donkey boiler flat. The crew is berthed in the forecastle, the captain and mate amidships on the bridge, and the engineers abreast the engine room casing. The vessel is fitted with two masts, four derricks and three winches.

The hull is constructed of steel in the ordinary way and of usual ship qualities to Lloyd's tests. It is interesting to note that the majority of the steel was ordered neat, or, at any rate, with less working allowance than is usual. Several types of joints were used. Butts or ends of the shell plates are joined together by a continuous butt weld, this weld being backed by a light plate strap. In other cases plates are overlapped with a heavy continuous weld on both edges. The sides or edges of the shell plates are overlapped and continuously welded on both edges, one being a heavy and the other a light weld, or sometimes with a butt weld and strap, as described above. Other connections were made by light continuous welds for watertight work, intermittent or tack welding on edges of angle bars to plates or of plates to plates where non-watertight.

Propulsion of the welded motorship *Fullagar* is by a "Cammellaird-Fullagar" oil engine of 500 brake horsepower running at a speed of 100 to 120 revolutions per minute. The engine has four cylinders, each 14 inches diameter. Each piston has a stroke of 20 inches and works on the Diesel cycle. Air at a pressure of 1,000 pounds per square inch is used for injecting the fuel into the cylinders. A 3-stage air compressor is driven from the forward end of the crankshaft, the circulating pumps being arranged forward of that again, thus rendering the engine a self-contained propelling unit.

The savings in weight and space effected by this type of engine are now well known, and the builders' courage and foresight in adopting it have been amply rewarded by the satisfactory trials just carried out by the latest addition to Britain's fleet of motor vessels. The hull and machinery have been built by Cammell Laird & Company, Ltd., Birkenhead, under the supervision of Messrs. G. S. Goodwin & Company, consulting engineers, of Liverpool, and the vessel has been purchased by Messrs. Thos. & Jno. Brocklebank, Ltd.

On June 29 trials of the *Fullagar* were carried out in the river Mersey, the party on board consisting of engineers and shipbuilders from all parts of the country. The ease and quickness with which the engine could be maneuvered were especially noteworthy. From full speed ahead to full speed astern required only about 10 seconds, the engine easily starting action with full ahead way on the ship.

At about 11:40 P. M. on the same day she set off on her maiden trip to the Clyde. After getting clear of land extremely rough weather was encountered, and as this

(*Concluded on page* 744.)

Subdivision of Passenger Vessels*

A Simplified Method for Obtaining the Curves of Floodable Length in the Design of a Ship

BY GEORGE WEBSTER, M. SC.

THE method of obtaining the subdivision of passenger vessels proposed by the Bulkhead Committee and adopted by the Board of Trade has received much adverse criticism.

Objections have been raised not only to the intricate and laborious nature of the calculations, especially the "correction for form," but also to their indirect character. The permissible draft of a ship can seldom be obtained by one calculation, and generally has to be obtained by "trial and error," which means repeating the calculations two or three times. In addition, further time is taken up by the Board of Trade in examining the calculations. Great advantage would therefore be gained if a simpler, quicker and more direct method of obtaining the flooding curve for a ship could be devised.

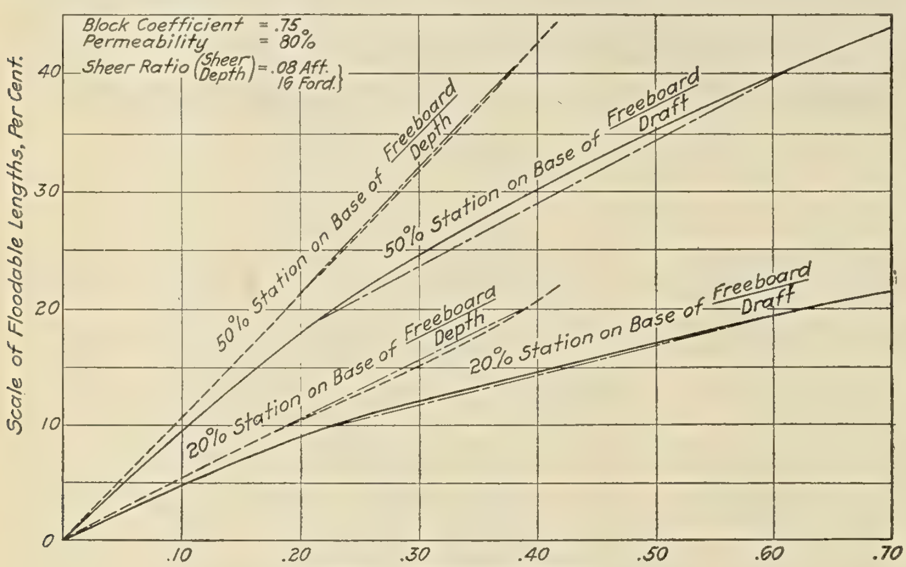


Fig. 1.—Cross Curves of Floodable Lengths

With this object in view, it is necessary to consider the variables which affect the flooding calculations.

The floodable length l at any point in the ship has been shown by the Bulkhead Committee to be dependent upon:

(1) Freeboard ratio $= \frac{\text{freeboard}}{\text{draft}}$.

(2) Permeability.

(3) Sheer ratio $= \frac{\text{sheer}}{\text{draft}}$.

(4) Block coefficient.

(5) Form of ship.

(6) Length of ship.

If the floodable length is expressed as a percentage of the length of the ship, item (6) disappears. Of the remaining five variables, the last one, i. e., "form of ship," is the most difficult to take account of, and if this could be omitted the problem would be considerably simplified.

The Standard Curves prepared by the Bulkhead Committee take account of the first four of these variables, and introduce the "Correction for Form" as a modification to the results obtained from the curves.

The work would be simplified further if the freeboard and sheer ratios could be expressed in terms of the known quantity *depth* instead of the unknown quantity *draft*.

It is now necessary to examine the effect on the floodable length of variations in each of the above variables.

Floodable Length and Freeboard Ratio

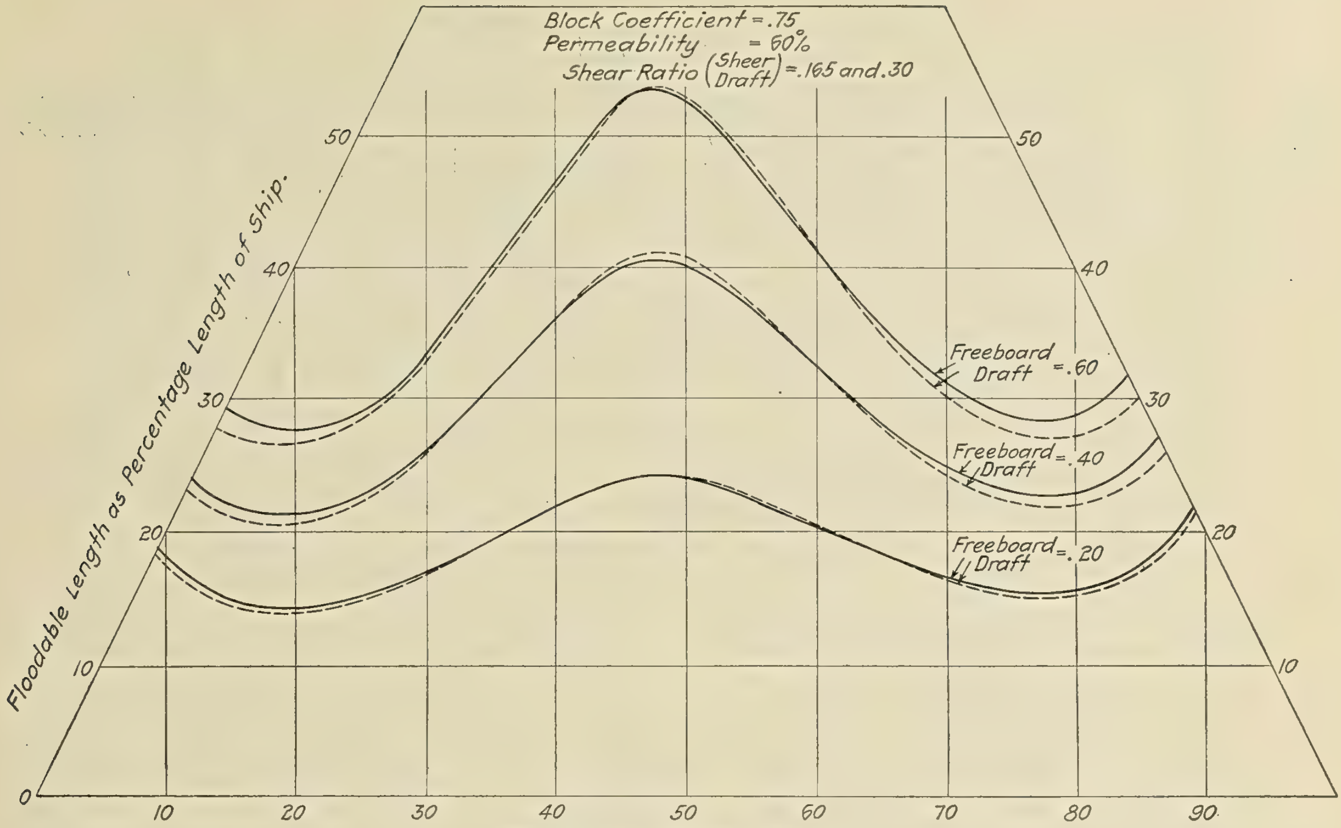
A series of cross curves of floodable length on a base of freeboard ratio $\left(\frac{\text{freeboard}}{\text{draft}}\right)$ were obtained from the Bulkhead Committee's Standard Curves, and a similar series on the base of $\frac{\text{freeboard}}{\text{depth}}$ were also plotted. The curves are somewhat of the form shown in Fig. 1. For freeboard ratios greater than 0.20, the curves are of a very flat nature, especially if plotted on a base of $\frac{\text{freeboard}}{\text{depth}}$, when they approach very nearly to straight lines. Consequently, if the floodable length be assumed to vary directly with $\frac{\text{freeboard}}{\text{depth}}$, no great error will be involved, and whatever small error there is, it will be less than would be incurred if the floodable length was taken to vary directly with $\frac{\text{freeboard}}{\text{draft}}$.

The freeboard ratios of a number of vessels were examined and it was found that values of $\frac{\text{freeboard}}{\text{depth}}$ less than 0.18 or greater than 0.38 (equivalent to $\frac{\text{freeboard}}{\text{draft}}$ of 0.219 and 0.613) are seldom, if ever, met with in practice. It therefore appears that the floodable length can without very great error be assumed to vary directly with the freeboard ratio, provided the latter is expressed in terms of the depth instead of the draft $\left(\text{i. e.}, \frac{\text{freeboard}}{\text{depth}}\right)$ and is within the above-mentioned limits.

Floodable Length and Permeability

The Standard Curves already referred to, prepared by the Bulkhead Committee, give floodable lengths for two extreme permeabilities, viz., 60 percent and 100 percent. Floodable lengths for intermediate permeabilities are ob-

* From a paper read before the Institution of Naval Architects, Liverpool, July 7, 1920.



Actual curves shown in full. Obtained from Bulkhead Committee's Standard Curves. Approximate curves shown dotted. Obtained by assuming floodable length varies inversely with permeability.

Fig. 2.—Typical Flooding Curves

taind by assuming that the differences in floodable lengths between the two sets of curves vary in the inverse ratio of the differences in the permeabilities.

For example, if l_1 and l_2 be the floodable lengths for permeabilities of 60 percent and 100 percent respectively, then the floodable length l_u for any permeability u intermediate between 60 percent and 100 percent is given by:

$$l_u = l_2 + \left[(l_1 - l_2) \frac{\left(\frac{1}{u} - \frac{1}{100}\right)}{\left(\frac{1}{60} - \frac{1}{100}\right)} \right]$$

A reduction in labor would be obtained if the results could be derived from one set of diagrams instead of two. This might be arranged if the floodable length can be assumed to vary inversely with the permeability. Then

$$l_u = l_1 \times \frac{60}{u},$$

or

$$l_u = l_2 \times \frac{100}{u}.$$

Investigations of a number of cases have been made in order to ascertain the error involved when this assumption is made. Fig. 2 is a typical example, the full curves giving the floodable lengths for 60 percent permeability being obtained direct from the Bulkhead Committee's diagrams. The dotted curves give approximate floodable lengths for 60 percent permeability, and were obtained by assuming the floodable lengths to vary inversely with the permeability between 80 percent and 60 percent, i. e., the floodable lengths for 80 percent permeability were obtained from the Bulkhead Committee's diagrams and were modified in the ratio of 80 to 60.

It is seen that towards the ends of the ships the approximate method gives results which are less than the actual (i. e., they err on the safe side), while towards amidships there is practically no difference in the two curves. Consequently, since the permeability in the majority of ships lies between about 65 percent and 85 percent, and since freeboard ratios $\left(\frac{\text{freeboard}}{\text{draft}}\right)$ much greater than 0.40 are unusual, it is seen that no great error will be introduced if flooding ordinates for 80 percent permeability only are given, and floodable lengths for any other permeability are obtained by modifying these given ordinates in the inverse ratio of the permeabilities.

The permeability of machinery spaces is laid down by the Bulkhead Committee to be 80 percent (except in motor vessels, when it is 85 percent), and thus the midship portion of the flooding curve can be obtained very quickly if, as proposed, 80 percent is adopted as the basis permeability.

Floodable Length and Sheer Ratio

The block coefficient, to some extent, affects the errors involved, when the above assumptions for permeability are made, but not to a very marked degree. The errors are least when the block coefficient is between about 0.65 and 0.75, but with the more unusual block coefficients lying in the neighborhood of 0.55 and 0.85 the errors will be slightly greater. Block coefficients greater than 0.80 or less than 0.60 are seldom, if ever, met with in practice, and if the straight line law for permeability be assumed within these limits, no serious error will be involved.

It has been shown above that it will be convenient to

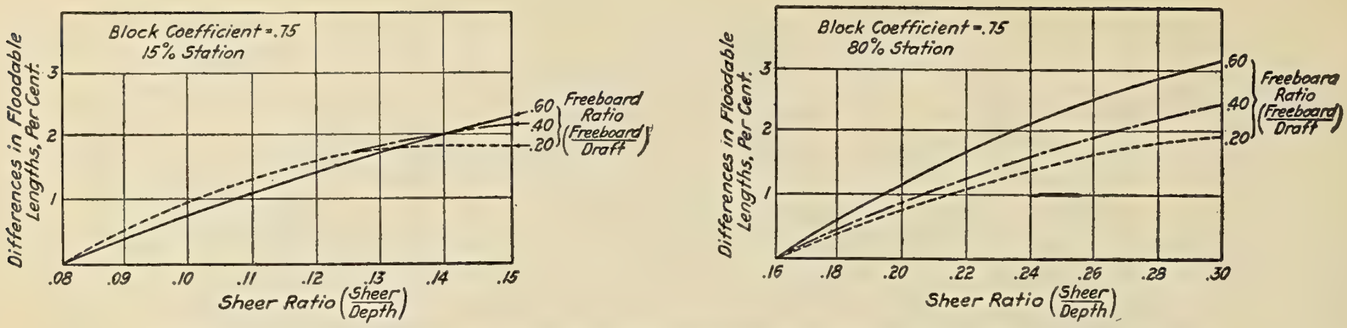


Fig. 3.—Curves Showing Variation in Floodable Length Between Highest and Lowest Assumed Sheer Ratios

express the freeboard ratio in terms of the depth instead of draft, and therefore it will be an advantage to express the sheer ratio in terms of the same quantity.

With a view to ascertaining reasonable maximum and minimum values, examination of these ratios has been made for a number of vessels, and values have also been obtained by using the standard sheers given by the Load Line Committee. It is found that reasonable ranges of sheer ratio $\left(\frac{\text{sheer}}{\text{depth}}\right)$ might be taken to be 0.08 to 0.15 aft and 0.16 to 0.30 forward. Sheers giving ratios outside these limits are very exceptional.

Curves showing the variation in the floodable lengths for variations in sheer ratios between the above limits were obtained for block coefficients between 0.55 and 0.85, and for the above suggested limits of freeboard ratios.

Fig. 3 shows a typical example, and as these curves are of a very flat nature, no great error will be involved if the floodable length is assumed to vary directly with the sheer ratio $\left(\frac{\text{sheer}}{\text{depth}}\right)$ between the highest and lowest assumed limits.

Floodable Length and Block Coefficient

Examination of the effect of block coefficient on floodable length showed that while an increase in the block coefficient increases the length of the flooding ordinates amidships, it reduces the length of those towards the end, and it does not appear possible to obtain any simple relation between these two items.

Summary of Conclusions

By assuming that the floodable length varies:

(1) Directly with the freeboard ratio $\left(\frac{\text{freeboard}}{\text{depth}}\right)$ between the limits of 0.18 and 0.38;

(2) Inversely with the permeability;

(3) Directly with the sheer ratio $\left(\frac{\text{sheer}}{\text{depth}}\right)$ between the limits of 0.08 and 0.15 aft, and 0.16 and 0.30 forward;

it is seen that no great error will be involved and considerable advantage will be gained, as it will be possible to simplify considerably the method of obtaining the floodable lengths.

Suggested Table for Obtaining Flooding Ordinates

As will be seen later, it is also a great advantage to express the freeboard and sheer ratios in terms of the known quantity depth instead of the unknown quantity draft, for it eliminates the necessity of having to obtain the draft by the "trial and error" method.

It is now necessary to ascertain a convenient method of tabulating the flooding ordinates when the above assumptions are made.

Fig. 4 shows a straight line drawn through a cross curve of floodable lengths on a base of freeboard ratio $\left(\frac{\text{freeboard}}{\text{depth}}\right)$. The proposal is to assume that the straight line $A\ B$ gives the required flooding ordinates instead of the curve $E\ F$.

If the line $A\ B$ is produced to meet the axis of X in C, the equation of the line is given by

$$y = m\ (a + x),$$

where m is the slope of the line, and a is the intercept $(C\ O)$ of the line on the axis of X beyond the origin.

Thus any ordinate of the cross curve of floodable lengths represented by the straight line $A\ B$ can be obtained if the values of m and a are known.

Cross curves of floodable lengths on a base of freeboard ratios $\left(\frac{\text{freeboard}}{\text{depth}}\right)$ were obtained for the stations in the ship given by the Bulkhead Committee, for a permeability of 80 percent, for block coefficients varying between 0.60 and 0.80 and for the highest and lowest assumed sheer ratios. Straight lines were then drawn through these curves between the above-mentioned limits of freeboard ratio in such a manner that the errors involved when the floodable length is obtained from the straight line instead of the curve are in every case the minimum possible. Variations in one quantity were set off against fluctuations in other quantities, and in many instances errors were in this manner completely eliminated.

From these graphs values of m and a were obtained, and these are shown in Table 1, from which it is possible to obtain a curve of floodable lengths for a permeability of 80 percent for any condition within the assumed limits by the formula:

$$l = m\ (a + f),$$

where l is the percentage floodable length; f, the freeboard ratio, is the ratio of the *freeboard* (measured from the subdivision load line to the lowest point of the margin line) to the *depth* (measured from the top of keel to the

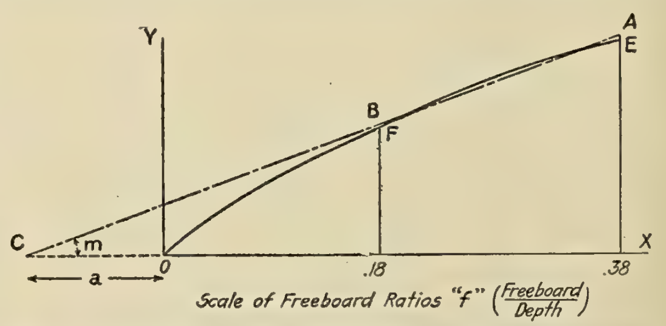


Fig. 4.—Diagram Showing Straight Line Drawn Through Cross Curve of Floodable Lengths

Table I.—Floodable Length Factors.

AFTER BODY

Block Coefficient.	Sheer Ratio.	A.T.		15 percent		20 percent		30 percent		40 percent		45 percent	
		m.	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*
0.60	0.15	41.2	0.275	57.4	0.077	57.7	0.045	66.9	0.021	96.3	—0.013	104.9	—0.020
	0.08	40.0	0.250	55.9	0.044	55.2	0.018	63.7	0.001	92.0	—0.017	104.3	—0.022
0.62	0.15	40.9	0.268	56.6	0.072	56.8	0.044	66.0	0.024	95.3	—0.008	105.1	—0.017
	0.08	39.4	0.248	54.9	0.041	54.2	0.017	62.8	0.004	91.2	—0.013	104.3	—0.019
0.64	0.15	40.6	0.261	55.9	0.067	55.9	0.043	65.1	0.027	94.4	—0.004	105.2	—0.014
	0.08	39.0	0.244	53.9	0.037	53.2	0.016	62.1	0.006	90.4	—0.009	104.3	—0.016
0.66	0.15	40.4	0.253	55.2	0.062	55.1	0.041	64.4	0.029	93.6	0.000	105.2	—0.012
	0.08	38.6	0.238	53.1	0.033	52.4	0.015	61.5	0.008	89.6	—0.005	104.2	—0.013
0.68	0.15	40.2	0.245	54.5	0.056	54.4	0.039	63.8	0.032	92.8	0.004	105.2	—0.009
	0.08	38.3	0.229	52.2	0.028	51.6	0.014	61.0	0.009	88.9	—0.001	104.1	—0.010
0.70	0.15	40.0	0.235	53.9	0.051	53.6	0.037	63.3	0.035	92.1	0.008	105.2	—0.006
	0.08	38.1	0.219	51.5	0.023	50.9	0.013	60.7	0.011	88.2	0.003	104.1	—0.007
0.72	0.15	39.9	0.225	53.2	0.046	53.0	0.036	62.9	0.038	91.5	0 012	105.2	—0.003
	0.08	38.0	0.207	50.7	0.018	50.2	0.012	60.6	0.012	87.6	0.007	104.2	—0.004
0.74	0.15	39.8	0.215	52.6	0.042	52.3	0.036	62.6	0.041	91.1	0.016	105.4	0.000
	0.08	38.0	0.194	49.9	0.015	49.5	0.012	60.5	0.014	87.2	0.011	104.4	—0.001
0.76	0.15	39.7	0.203	51.9	0.040	51.7	0.038	62.5	0.044	90.9	0.020	105.7	0.002
	0.08	38.0	0.180	49.1	0.013	49.0	0.013	60.5	0.017	86.9	0.015	104.7	0.001
0.78	0.15	39.7	0.190	51.2	0.040	51.1	0.041	62.5	0.048	90.9	0.023	106.1	0.005
	0.08	38.1	0.166	48.2	0.013	48.4	0.015	60.5	0.020	86.7	0.018	105.1	0.004
0.80	0.15	39.8	0.176	50.3	0.041	50.5	0.046	62.6	0.052	91.0	0.027	106.7	0.008
	0.08	38.2	0.152	47.2	0.015	47.9	0.018	60.6	0.024	86.7	0.021	105.7	0.006

FORE BODY.

Block Coefficient.	Sheer Ratio.	50 percent		60 percent		70 percent		80 percent		85 percent		F.T.	
		m.	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*	*m.*	*a.*
0.60	0.30	98.5	—0.017	72.9	0.012	55.7	0.048	56.3	0.080	61.7	0.0115	40.2	0.379
	0.16	97.0	—0.017	68.4	0.006	51.2	0.035	49.1	0.077	56.9	0.091	36.8	0.379
0.62	0.30	99.4	—0.015	74.2	0.012	56.0	0.045	55.4	0.077	60.8	0.110	40.1	0.368
	0.16	98.2	—0.015	69.5	0.007	51.4	0.032	48.4	0.073	55.8	0.087	36.8	0.365
0.64	0.30	100.3	—0.012	75.3	0.013	56.2	0.044	54.7	0.074	59.9	0.104	39.9	0.359
	0.16	99.2	—0.012	70.4	0.009	51.6	0.031	47.8	0.069	54.6	0.083	36.8	0.353
0.66	0.30	101.1	—0.009	76.2	0.015	56.3	0.044	53.9	0.071	59.0	0.098	39.6	0.350
	0.16	100.2	—0.010	71.0	0.012	51.8	0.031	47.3	0.065	53.4	0.079	36.7	0.341
0.68	0.30	101.9	—0.005	76.9	0.018	56.4	0.046	53.2	0.068	58.2	0.093	39.4	0.342
	0.16	101.0	—0.006	71.6	0.015	52.0	0.032	46.7	0.062	52.3	0.076	36.6	0.330
0.70	0.30	102.6	—0.002	77.6	0.022	56.6	0.048	52.5	0.066	57.3	0.087	39.1	0.333
	0.16	101.8	—0.004	72.1	0.019	52.2	0.034	46.2	0.059	51.2	0.072	36.5	0.319
0.72	0.30	103.5	0.001	78.4	0.025	56.9	0.050	52.0	0.065	56.4	0.082	38.8	0.324
	0.16	102.7	—0.001	72.8	0.023	52 5	0.037	45.8	0.057	50.1	0.059	36.4	0.308
0.74	0.30	104.4	0.004	79.5	0.028	57.4	0.053	51.5	0.064	55.6	0.076	38.6	0.314
	0.16	103.6	0.002	73.9	0.026	52.9	0.039	45.4	0.056	49.0	0.066	36.3	0.296
0.76	0.30	105.6	0.006	81.0	0.029	58.2	0.056	51.0	0.064	54.9	0.070	38.4	0.303
	0.16	104.8	0.004	75.3	0.028	53.6	0.042	45.1	0.054	48.0	0.062	36.2	0.283
0.78	0.30	107.0	0.008	83.1	0.030	59.4	0.059	50.7	0.065	54.2	0.065	38.4	0.288
	0.16	106.3	0.006	77.2	0.028	54.5	0.046	44.9	0.054	47.1	0.059	36.2	0.269
0.80	0.30	108.6	0.009	85.6	0.030	60.9	0.062	50.4	0.066	53.5	0.059	38.5	0.272
	0.16	108.0	0.007	79.5	0.028	55.6	0.049	44.8	0.054	46.3	0.055	36.2	0.253

This Table applies to all cases where—
1. The freeboard ratio varies from 0.18 to 0.38. 2. The sheer ratio varies from 0.16 to 0.30 forward and from 0.08 to 0.15 aft. 3. The block coefficient varies from 0.60 to 0.80.

NOTE—For the forward and after terminals the ordinate of the flooding curve as given by the formula must be plotted on a vertical line situated at a distance from the particular terminal equal to one-half the floodable length given by the formula for a permeability of 80 percent.

lowest point of the margin line). The margin line is parallel to the bulkhead deck at side line and 3 inches below the upper surface of that deck; *m* and *a* are factors obtained from the table.

Block coefficient is the displacement volume to molded lines, divided by length on the subdivision load line multiplied by molded breadth and by draft from top of keel. *Sheer ratio* (forward or aft) is the ratio of the *sheer* of the margin line at the ends (measured from a line drawn through the lowest point of the margin line parallel to the subdivision load line) to the *depth* (measured from the top of keel to the lowest point of the margin line).

Values of *m* and *a* for block coefficients or sheer ratios intermediate between those given in the table are obtained by linear interpolation, and, since it has been shown that the floodable length can be taken to vary inversely with the permeability, the floodable length for any permeability is given by:

$$l = \frac{80}{u} [m (a + f)],$$

when *u* is the permeability.

CORRECTION FOR FORMS

In the foregoing no account has been taken of the fifth item on page 726, viz., *Form of Ship.*

Usually the effect of this correction is small, but in exceptional cases it may be large. It also generally increases the lengths of the flooding ordinates given by the Bulkhead Committee's diagrams (see Professor Welch, Trans. I.N.A., 1915, Vol. LVII., p. 14), and therefore its omission would be an error on the safe side.

Table II.—Comparison of Floodable Length to Board of Trade and to Estimated Actual Permeability Taking Freeboard Ratio into Account.

Ship.	Voyage.	Draft. Leaving. Ft. In.	Draft. Summer. Ft. In.	Freeboard Ratio = Freeboard / Draft. Leaving.	Freeboard Ratio Summer.	Nature of Cargo.	Permeability, percent. Actual Forward.	Actual Aft.	To Board of Trade. Forward.	To Board of Trade. Aft.	Floodable Length Error due to Freeboard Ratio and Permeability. Forward. Measured at 80% L from Aft End.	Aft. Measured at 20% L from Aft End.	Permeability by Proposed Formula $U = 63 + \left\{ 32 \frac{h}{H} \right\} + C$. Forward.	Aft.	Percentage Error Proposed Formula and Board of Trade Method. Forward.	Aft
Ship "A"	5 home	28 6	31 3	0.405	0.282	Mutton, Wheat, Wool, Skins	55.2	60.3	65.2	66.5	27.3	47.2	65.5	65.0	+0.5	—2.3
Ship "B"	home	24 0½	27 3	0.45	0.282	Tobacco, Rubber, Copra, Sago	67.8	66.1	64.2	64.1	26.6	36.1	63.0	64.0	—1.9	Nil
Ship "B"	6 home	26 1½	27 3	0.337	0.282	Copra, Hemp, Tea, Rubber, Nuts,	60.9	56.5	64.2	64.1	18.0	27.3	63.0	64.0	—1.9	Nil
Ship "B"	7 home	26 1½	27 3	0.337	0.282	Copra, Hemp, Tea, Rubber, Nuts,	65.5	61.1	64.2	64.1	10.0	17.85	63.0	64.0	—1.9	Nil
Ship "C"	1 home	26 6	28 2	0.331	0.253	Tobacco, Hemp, Rubber, Copra, Sessamun Seeds	60.0	57.7	64.1	64.0	24.9	28.8	63.0	64.0	—1.75	Nil
Ship "C"	2 home	25 4¾	28 2	0.391	0.253	Tobacco, Rubber, Hides, Tea, Nuts, Sessamun Seeds	63.5	63.3	64.1	64.0	29.5	29.5	63.0	64.0	—1.75	Nil
Ship "C"	3 home	25 9	28 2	0.371	0.253	Tobacco, Hemp, Hides, Tea, Nuts, Sessamun Seeds	59.9	62.5	64.1	64.0	32.9	26.9	63.0	64.0	—1.75	Nil
Ship "C"	10 home	26 1	28 2	0.354	0.253	Hemp, Copra, Hides	62.6	61.2	64.1	64.0	24.3	25.6	63.0	64.0	—1.75	Nil
Ship "D"	12 home	28 5½	30 9¼	0.495	0.382	Peas, Rice, Hemp, Sago, Copra	59.0	61.3	63.3	65.2	23.9	25.6	63.0	65.6	—0.5	+0.6
Ship "D"	21 home	26 4	30 9¼	0.615	0.382	Hemp, Flour, Rubber, Tea	56.6	53.7	63.3	65.2	46.4	68.5	63.0	65.6	—0.5	+0.6
Ship "E"	37 home	23 0½	25 3	0.387	0.265	Tobacco, Sessamun Seeds, Nuts	65.3	64.5	63.3	63.7	19.7	23.7	63.0	64.0	—0.5	+0.5
Ship "E"	47 home	22 5	25 3	0.425	0.265	Copra, Rubber, Gambier	62.5	62.5	63.3	63.7	32.0	35.5	63.0	64.0	—0.5	+0.5
		Indian Summer														
Ship "F"*	26 home	27 2½	26 8½	0.298	0.322	Rice	58.2	57.7	63.2	63.2	5.4	2.6	63.0	64.0	—0.3	+1.2
Ship "F"	27 home	25 8½	26 8½	0.373	0.322	Rice, Copra, Maize, Beans	58.6	55.8	63.2	63.2	22.2	25.5	63.0	64.0	—0.3	+1.2
Ship "G"	6 home	24 1½	32 1¼	0.763	0.324	Hemp and Lumber (Passengers in 'tween decks)	64.5	64.7	69.6	71.8	65.0	82.5	69.1	71.25	—0.7	—0.8
Ship "G"	7 home	27 1	32 1¼	0.57	0.324	Salmon, Hemp, Lumber	59.2	59.8	63.7	64.5	44.0	53.0	63.3	65.6	—1.1	+1.7
Ship "H"	10 home	25 5	27 3	0.374	0.282	Hemp, Tapioca	59.0	57.3	64.2	64.1	28.9	36.5	63.3	64.0	—1.9	Nil
Average	......	......	......	......	......		61.1	60.3	64.2	64.7	28.3	34.9	63.5	64.8	-1.00	+0.155

All the above examples, with the exception of Ship *H*, were taken at random—i. e., voyages were not specially chosen.

In all of the above cases the whole of the cargo space was occupied, except in the case of Ship *G*, Voyage 6, when passengers were carried in 'tween decks. *This vessel has no sheer.

The Bulkhead Committee assigned a permeability of 60 percent to all cargo spaces in a ship. It is obvious that this can only be an average figure, for the permeability of the holds of a vessel laden with iron ore would be considerably higher than 60 percent, while, on the other hand, the permeability of the holds of a vessel laden with a very light substance (hemp, for example) would be much less than 60 percent. In addition, it should be noted that the holds of the latter vessel would probably be full before the vessel was down to her maximum assigned draft, while in the former vessel there would be space in the holds for utilizing considerably more than this maximum draft if it were permitted. Thus an assumption of 60 percent for the permeability of all cargo holds might not only involve errors due to the different natures of cargoes, but there might also be errors due to variation in freeboard ratio, especially on the homeward voyages. This question has been exhaustively examined by Mr. G. W. Barr, of Messrs. Alfred Holt & Company, by whose courtesy the results shown in Table II are given.

The freeboards and permeabilities shown in this table are worked out for actual voyages, and the permeabilities of most of the different kinds of cargoes were determined experimentally.

It is seen that although the average of the actual permeabilities is not very different from that laid down by the Bulkhead Committee, yet the average errors in floodable lengths due to the variations in the freeboard ratios in actual practice are as much as 30 percent. These errors, it will be noted, are in the direction of making the ship safer.

It therefore appears that it is possible that the errors involved in assuming a fixed permeability for all cargoes, irrespective of their densities, might be much greater than those involved if the *Correction of Form* is omitted.

While it must be recognized that permeability of 60 percent appears to be a reasonable mean value for cargo spaces, it does not, in view of the foregoing, appear to be unreasonable to omit the *Correction for Form* altogether, especially when it is remembered that this variable is the most difficult of all to take account of, and that its omission would be an error on the safe side.

Calculation of Permeability

Under the present Board of Trade regulations it is necessary to ascertain the volumes of the various compartments in order to obtain the permeability. In the early stages of the design this information is not always easy to obtain, and the work would be simplified if the permeabilities could be based on figures which are readily available.

It has been found that the following formula, embodying only figures obtainable from the middle-line section, gives the permeabilities very closely:

$$\text{Permeability} = 63 + 32 \frac{h}{H} + C,$$

where h is the mean depth below the bulkhead deck of the 95 percent spaces as defined in the present Board of Trade Regulations

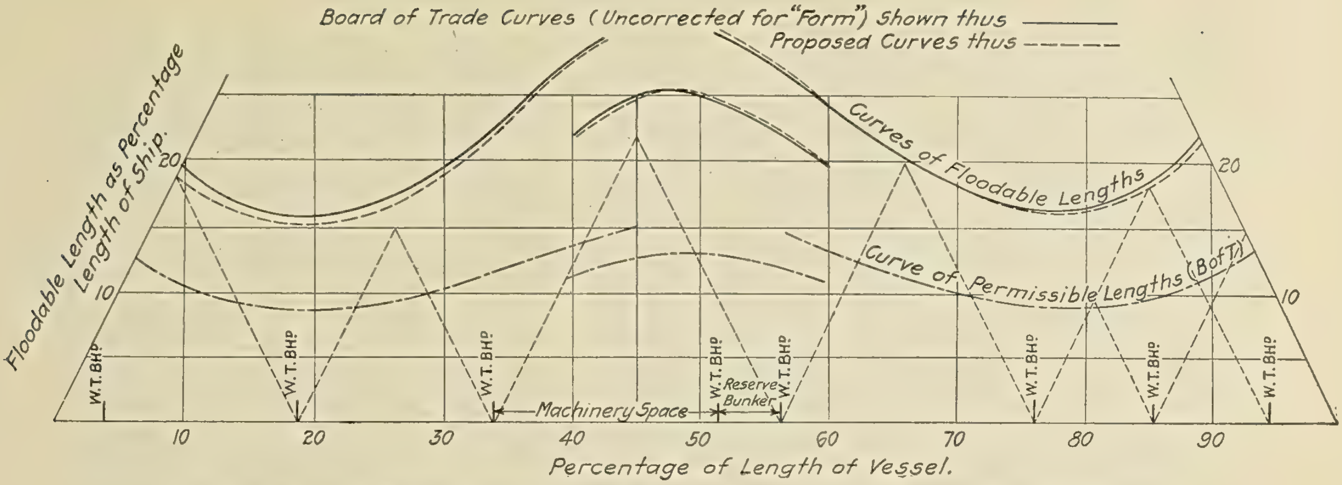


Fig. 5.—Typical Curves of Floodable Length by the Board of Trade Rules and by the Proposed Methods for a Vessel 560 Feet by 68 Feet by 43 Feet

(exclusive of double bottom, peaks and tunnels), reduced in proportion which the mean length of such spaces bears to the length of the vessel measured between the forward machinery space bulkhead and the collision bulkhead, or between the aft machinery space bulkhead and the after peak bulkhead. The mean depth is to be measured from top of deck to top of deck at centerline.

H is the depth of the vessel from the top of keel to the margin line midway between the end of the machinery space and the forward or after end of the vessel.

C is zero for the forward end, 1 for the after end in single-screw vessels, and 2 for the after end in twin-screw vessels.

The permeability of machinery spaces in taken to be 80 percent for steamships and 85 percent for ships fitted with internal combustion engines.

This formula has been applied to the vessels given in Table II, and the results are included in that table.

It will be observed that the formula gives results which are on the average within 0.5 percent of those obtained by the Board of Trade method. It is evident, therefore, that no appreciable error will be involved if this formula is used for obtaining the permeability.

By means of the equation at the bottom of page 729, Table I, and the above equation for permeability, the flooding curve for any vessel can be obtained in about half an hour.

This method of obtaining flooding curves has been applied to a large range of ships, and it is found that the lengths of flooding ordinates obtained by this method are, on the average, within 2 or 3 percent of the floodable lengths obtained by the Bulkhead Committee's curves (but uncorrected for *form*).

A typical example showing a comparison of curves obtained by these two methods is shown in Fig. 5, and a typical example showing the small amount of labor in the calculation is shown in Appendix I.

Draft Penalty for a Long Hold

It should be noted that in obtaining values from Table II it is only necessary to read values of m to one decimal place, and values of a to three decimal places.

For instance, suppose in the example given in Appendix I the value of m at 15 percent station was 52.7 instead of 52.6, then the value of the flooding ordinate would be 15.87 instead of 15.84. Similarly, if the value of a at the same station was 0.042 instead of 0.041, then the flooding ordinate would be 15.90 instead of 15.84. The differences in both of these cases are much too small to affect the results in actual practice.

It will be observed that this method of obtaining the flooding curves is not only simple of application and involves little labor, but also enables the draft penalty for a long hold to be obtained.

Suppose in the example given in Appendix I that a hold 20 percent of the length of the vessel is required, with its center of length at 70 percent station.

The corresponding length of hold, if the permeability was 80 percent, would be:

$$20 \times \frac{63}{80} = 15.75 \text{ percent (permeability forward} = 63 \text{ percent)},$$

$$15.75 = m\ (a + f) = 56.7\ (0.050 + f),$$
$$f = 0.0228,$$

and

$$f = \frac{\text{freeboard}}{\text{depth}} = \frac{\text{freeboard}}{35}.$$

$$\text{freeboard} = 7.98 \text{ feet},$$
$$\text{draft} = 35 - 7.98 = 27.02 \text{ feet}.$$

Reduction in draft = 28.0 — 27.02 = 0.98 feet, i. e., draft penalty = 0.98 feet = 12 inches (say).

The same method is applied for obtaining the correct permissible draft for a given spacing of bulkheads, if the first approximation should not be correct.

It has been shown that the results obtained by this method of calculation agree quite closely enough for all practical purposes with those given by the Board of Trade method, and in view of the extreme simplicity of application and the enormous saving in time and labor which the method affords, it is considered that it could be very profitably substituted for the present laborious and intricate method of calculation.

On examining Table I it will be seen that for a given station the difference between the values of m for the highest and lowest assumed sheer ratios is fairly constant for all block coefficients, and similarly for values of a. It therefore appears that Table I might be further simplified by giving values of m and a for one sheer ratio only instead of two, and giving for each station a correction factor which would have to be applied if the sheer ratio differed from that for which the table was drawn up.

Tables III and IV are drawn up on this basis, the values of m and a being correct for sheer ratios midway between the maximum and minimum sheer ratios of Table I, i. e., the values of m and a in Tables III and IV are correct for sheer ratios of 0.115 aft and 0.23 forward, and the necessary correction for every 0.01 alteration in the sheer ratio is given for each station.

These sheer corrections are correct for a block coefficient of 0.70, and in cases where the difference between the values of m (and a) for the two sheer ratios given in

Table III.—Values of m.

Sheer Ratio (S/D) = 0.115. Sheer Ratio (S/D) = 0.23.

Block Coefficient	Station.											
	A.T.	15	20	30	40	45	50	60	70	80	85	F.T.
0.60	40.60	56.66	56.43	65.30	94.18	104.70	97.75	70.65	53.43	52.67	59.33	38.50
0.61	40.40	56.20	55.95	64.83	93.70	104.70	98.30	71.25	53.60	52.29	58.83	38.46
0.62	40.20	55.75	55.48	64.39	93.25	104.70	98.83	71.81	53.72	51.90	58.32	38.42
0.63	40.00	55.32	55.01	63.98	92.82	104.70	99.32	72.33	53.82	51.56	57.80	38.38
0.64	39.80	54.90	54 56	63.60	92.40	104.70	99.80	72.81	53.90	51.21	57.27	38.33
0 65	39.65	54.50	54.14	63.25	92.00	104.70	100.25	73.24	53.96	50.88	56.73	38.26
0.66	39.50	54.11	53.74	62.93	91.60	104.70	100.68	73.61	54.03	50.56	56.20	38.18
0.67	39.36	53.73	53.35	62.65	91.21	104.70	101.09	73.93	54.11	50.25	55.70	38.09
0.68	39.23	53.36	52.98	62.40	90.84	104.70	101.48	74.23	54 20	49.95	55.20	38.00
0.69	39.12	53.00	52.61	62.18	90.49	104.70	101.85	74.53	54.30	49.65	54.70	37.90
0.70	39.03	52.65	52.25	61.99	90.16	104.70	102.24	74.85	54.40	49.37	54.21	37.80
0.71	38.96	52.30	51.90	61.83	89.86	104.70	102.65	75.21	54.53	49.12	53.73	37 70
0.72	38.92	51.96	51.57	61.70	89.60	104.70	103.08	75.62	54.70	48.88	53.27	37.60
0.73	38.90	51.62	51.25	61.60	89.37	104.79	103.55	76.11	54.91	48.65	52.81	37.51
0.74	38.90	51.26	50.94	61.53	89.17	104.90	104.06	76.70	55.18	48.44	52.35	37.43
0.75	38.90	50.88	50.63	61.50	88.01	105.03	104.62	77.39	55.52	48.24	51.90	37.36
0.76	38.90	50.50	50.33	61.50	88.91	105.20	105.25	78.18	55.93	48.07	51.47	37.30
0.77	38.90	50.10	50.03	61.50	88.85	105.40	105.95	79.09	56.41	47.92	51.05	37.28
0.78	38.90	49.69	49.75	61.50	88.82	105.64	106.70	80.14	56.96	47 80	50 65	37.28
0.79	38.90	49.26	49.47	61.50	88.82	105.92	107.49	81.31	57.59	47.70	50.27	37.28
0.80	38.90	48.80	49.20	61.50	88.82	106.23	108.30	82.60	58.30	47.60	49.90	37.28
Correction for 0.01 alteration in sheer ratio*	0.271	0.344	0.397	0.357	0.557	0.157	0.0585	0.387	0.314	0.450	0.4375	0.180

* Correction to be { added / subtracted } according as sheer ratio is { greater / less } than sheer ratio of table.

Table IV.—Values of a.

Sheer Ratio (S/D) = 0.115. Sheer Ratio (S/D) = 0.23.

Block Coefficient	Station.											
	A.T.	15	20	30	40	45	50	60	70	80	85	F.T.
0.60	0.2625	0.0610	0.0315	0.0110	−0.0150	−0.0210	−0.0170	0.0085	0.0412	0.0790	0.1035	0.3788
0.61	0.2604	0.0590	0.0310	0.0125	−0 0130	−0.0195	−0.0160	0.0088	0.0398	0.0769	0.1010	0.3722
0.62	0.2580	0.0569	0.0305	0.0138	−0.0110	−0.0180	−0.0146	0.0092	0.0388	0.0749	0.0985	0.3665
0.63	0.2553	0.0547	0.0300	0.0150	−0.0090	−0.0165	−0.0132	0.0100	0.0380	0.0730	0.0960	0.3610
0.64	0.2523	0.0525	0.0294	0.0162	−0.0069	−0.0150	−0.0118	0.0110	0.0375	0.0712	0.0935	0.3555
0.65	0.2490	0.0501	0.0288	0.0174	−0.0048	−0.0135	−0.0104	0.0122	0.0375	0.0695	0.0910	0.3505
0.66	0.2454	0.0476	0.0281	0.0186	−0.0027	−0.0120	−0.0090	0.0135	0.0378	0.0679	0.0886	0.3455
0.67	0.2414	0.0449	0.0273	0.0197	−0.0006	−0.0105	−0.0075	0.0150	0.0383	0.0664	0.0862	0.3407
0.68	0.2370	0.0421	0.0265	0.0208	+0.0015	−0.0091	−0.0060	0.0167	0.0390	0.0651	0.0840	0.3360
0.69	0.2322	0.0393	0.0257	0.0218	0.0035	−0.0077	−0.0045	0.0185	0.0400	0.0640	0.0820	0.3312
0.70	0.2270	0.0367	0.0250	0.0228	0.0055	−0.0063	−0.0030	0.0203	0.0410	0.0630	0.0799	0.3263
9.71	0.2216	0.0342	0.0245	0.0238	0.0075	−0.0049	−0.0015	0.0222	0.0420	0.0620	0.0777	0.3214
0.72	0.2160	0.0320	0.0242	0.0248	0.0095	−0.0035	0.0000	0.0240	0.0430	0.0612	0.0755	0.3164
0.73	0.2103	0.0301	0.0242	0.0258	0.0115	−0.0022	+0.0013	0.0256	0.0445	0.0605	0.0733	0 3110
0.74	0.2044	0.0286	0.0242	0.0270	0.0135	−0.0009	0.0026	0.0270	0.0460	0.0600	0.0701	0.3052
0.75	0.1982	0.0275	0.0245	0.0284	0.0155	+0.0004	0.0038	0.0280	0.0475	0.0595	0.0689	0.2992
0.76	0.1917	0.0266	0.0252	0.0300	0.0173	0.0017	0.0050	0.0285	0.0490	0.0592	0.0666	0.2930
0.77	0.1850	0.0266	0.0263	0.0318	0.0191	0.0031	0.0060	0.0290	0.0507	0.0592	0.0643	0.2865
0.78	0.1782	0.0270	0.0279	0.0336	0.0208	0.0044	0.0068	0.0290	0.0525	0.0595	0.0620	0.2790
0.79	0.1712	0.0275	0.0298	0.0355	0.0223	0.0057	0.0074	0.0290	0.0540	0.0598	0.0595	0.2710
0.80	0.1640	0.0280	0.0320	0.0375	0.0238	0.0070	0.0080	0.0290	0.0555	0.0602	0.0570	0.2625
Correction for 0.01 alteration in sheer ratio*	0.0024	0.0040	0.0036	0.0034	0.0007	0.0002	0.0001	0.0002	0.0009	0.0005	0.0010	0.0010

* Correction to be { added / subtracted } according as sheer ratio is { greater / less } than sheer ratio of table.

Table I are constant for all block coefficients; the sheer corrections of Tables III and IV will be correct for all block coefficients, and in those cases Tables III and IV would give exactly the same results as Table I. In most cases, however, the above-mentioned differences are not constant for all block coefficients; but it will be noted that when these differences for values of *m* increase with increase of block coefficient, the corresponding differences for values of *a* decrease with increase of block coefficient, and vice versa.

Thus, on examining the values of *m* and *a* obtained from Tables III and IV, it is seen that when the value of *m* obtained by Table III is less than that obtained from Table I the value of *a* by Table IV is greater than that obtained from Table I, and vice versa. Consequently, the flooding ordinates given by these two methods are in very close agreement.

For example, for a block coefficient of 0.62, the values of *m* and *a* at 80 percent station for sheer ratios of 0.30 are 55.4 and 0.077 respectively by Table I, and 55.05 and

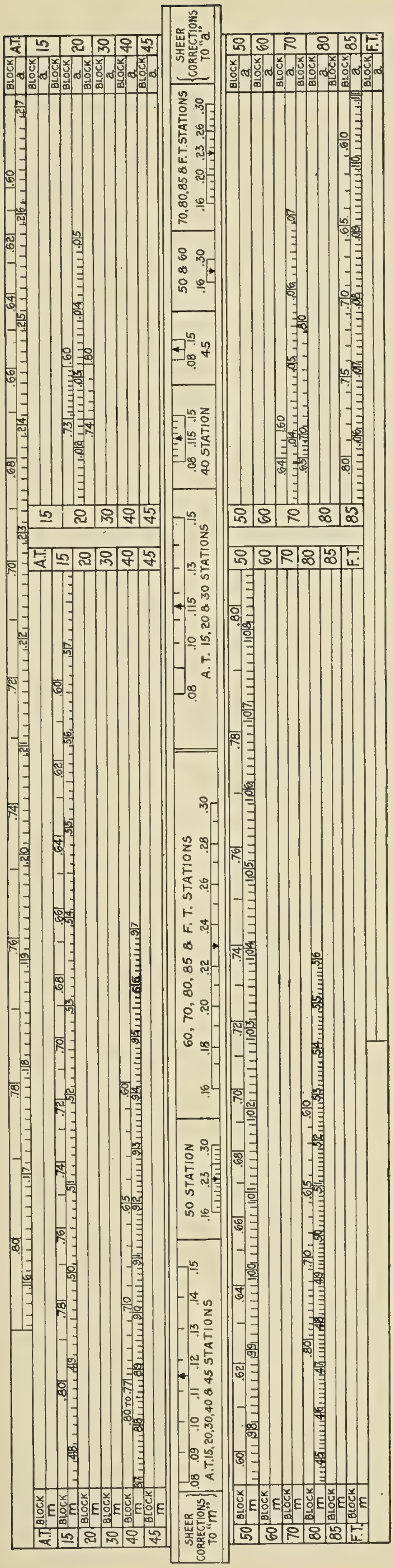


Fig. 6.—Slide Rule for Obtaining Flooding Curves

0.078 respectively as given by Tables III and IV.

Assuming a freeboard ratio of, say, 0.20, the former results give a flooding ordinate of $(55.4 \times 0.227) = 15.35$, while the latter results give a flooding ordinate of $(55.05 \times 0.278) = 15.35$.

It is thus seen that Tables III and IV give results which are in close agreement with those given by Table I.

Slide Rule for Obtaining Flooding Curves

It appears from the nature of Tables III and IV that it should be possible to construct a slide rule embodying the results contained in the tables.

There are three variables to be considered, viz., block coefficient, sheer ratio, and *m* (or *a*).

There are several ways in which these variables can be plotted in the form of a slide rule, but the simplest has been found to be as shown in Fig. 6. Values of block coefficients *m* and *a* are arranged on the fixed portion of the scale, while corrections to *m* and *a* for variations in sheer ratio are arranged on the sliding portion.

It is found that by varying the scales for values of *m* and *a* at different stations, it is possible to make one scale of corrections for sheer ratio do for several stations, and thus the amount of data on the slide is reduced to a minimum.

On examining Table IV, it will be noted that at some of the stations the values of *a* do not increase or decrease continuously with increase of block coefficient (stations 15, 20, 70 and 80). Consequently, in these cases there will be two block coefficients for one value of *a*. This difficulty can be overcome in plotting by dividing the scale of block coefficients into two, at the point where the values of *a* stop descending and commence to ascend (or vice versa), one portion of the divided scale of block coefficients being arranged above the scale of *a* and the other portion below it (see Fig. 6).

By means of this slide rule it is now possible to obtain the ordinates of the flooding curve for a ship in less than ten minutes.

The line of the cursor is placed over the required block coefficient for any given station. If the sheer ratio is normal (i. e., 0.115 aft or 0.23 forward), the value of *m* (or *a*) can be read off from the scale of *m* (or *a*) immediately below the scale of block coefficients. If, however, the sheer ratio is not normal, the sliding scale is moved until the normal sheer ratio for the particular station is under the line of the cursor. The cursor is then moved until the line on it is over the required sheer ratio for the given station, and the value of *m* (or *a*) for the given station under the line of the cursor is read off.

Knowing, therefore, the block coefficient and the sheer ratio, the values of *m* and *a* can be obtained for each station in the ship from the slide rule, and by the method shown in Appendix I the ordinates of the flooding curve can be quickly found.

APPENDIX I

Typical Calculation

A typical calculation for the floodable length curve is as follows:

s.s.........................

$452 \times 56.0 \times 35.25$

Depth to margin line..........................	= 35.0
Molded draft	= 28.0
Freeboard	7.0
Block coefficient	0.73
Freeboard ratio = $\frac{\text{freeboard}}{\text{depth}}$	0.20

Sheer forward = 10.0 sheer ratio forward $\frac{\text{sheer}}{\text{depth}}$. 0.286

Sheer aft = 5.0 sheer ratio aft $\frac{\text{sheer}}{\text{depth}}$ 0.143

No passengers below bulkhead deck.

$\therefore u = 63$ forward, and 64 aft (per formula on page 729).

				Floodable Length — Machinery Space	Floodable Length — Ends
Station	m	a	$a+f$	$m(a+f)$	$\frac{80}{u}[m(a+f)]$
A.T....	39.7	0.218	0.418	16.58	20.75
15.....	52.6	0.041	0.241	12.67	15.84
20.....	52.4	0.034	0.234	12.24	15.30
30.....	62.5	0.037	0.237	14.81	18.51
40.....	90.9	0.014	0.214	19.45	24.30
45.....	105.2	0.002	0.198	20.84	26.08
50.....	103.9	0.002	0.202	21.00	26.65
60.....	78.4	0.026	0.226	17.72	22.50
70.....	56.7	0.050	0.250	14.18	18.00
80.....	51.1	0.064	0.264	13.49	17.13
85.....	55.3	0.078	0.278	15.36	19.50
F.T....	38.5	0.317	0.517	19.88	25.25

NOTE.—For the forward and after terminals, the ordinate of the flooding curve as given by the formula must be plotted on a vertical line situated at a distance from the particular terminal equal to one-half the floodable length given by the formula for a permeability of 80 percent.

Report of Education Committee of the Engineering Section of the National Safety Council*

BY W. D. KEEFER

ALMOST everyone who is familiar with the engineering courses offered in the average technical school and university in our country agrees that our student engineers are being taught technical subjects that fit them to solve problems where materials, machines and forces of nature are involved, but that practically nothing is taught them to assist in solving the problems involving men.

The importance of this phase of engineering education was recently made apparent by the result of an investigation conducted by the Carnegie Foundation for the advancement of teaching. Starting in the year 1915, Dr. Mann sent out questionnaires to leading engineers all over our country asking them to state their views concerning the elements that make for the professional success of the engineer. A statistical summary of over 6,000 returns revealed the following:

	Percent
Character	24
Judgment	19.5
Efficiency	16.5
Understanding of men	15
Knowledge of fundamentals	15
Technique	10

This being true, the colleges cannot limit themselves to the teaching of those subjects which make for perfection in professional knowledge and technique. They must also consider the development of judgment, understanding of men, efficiency and character.

Many persons interested in safety think that a presentation of the principles of accident prevention to student engineers will assist materially in developing a proper understanding of men, and at the same time make a valuable addition to the student's engineering knowledge. They base this statement on the fact that successful safety work is the result not only of the proper application of true engineering principles but also of the ability to understand and handle men. Without stopping to discuss this in greater detail, let us consider for a moment how the engineering section of the council can best assist our engineering colleges.

The National Safety Council has in the past two years been devoting some time and money to the consideration of this problem, and at our suggestion Mr. George F. Blessing, now of the Rockefeller Foundation and formerly the professor in charge of engineering at Swarthmore College, a member of our education committee of this section of the council has outlined some practical suggestions. These suggestions have been submitted to the other members of this committee, and it is my pleasure to report to you the concensus of the comments of the committee thereon.

(1) Safety education in engineering colleges should not be confined to preparing safety engineers. A greater effort should be made to impress all engineering students with the fact that safety is an integral part of efficiency. Then when these students begin their real work, of whatever kind, they will know that the full measure of efficiency cannot be obtained without safety receiving full consideration. They will also have the knowledge to direct this work. Safety should therefore be worked into all engineering courses where it is appropriate. Such courses as machine design, shop practice, industrial management and others are particularly suitable for the inclusion of safety material.

(2) Safety can best be presented to the engineering educator as well as to the engineering student, as a subject definitely related to engineering efficiency, rather than as a humanitarian subject of general interest to everybody.

(3) Opportunities should be provided for any engineering professors who wish to do so to take up summer work in the safety departments of some of the large companies.

(4) Encourage colleges to take out a $15-a-year membership in the National Safety Council, which membership will make available all the council's bulletins and other publications.

(5) Urge colleges to post safety bulletin boards in the engineering shops and keep them alive with the council's bulletins and other literature pertaining to Safety.

(6) Assist engineering colleges in establishing individual safety museums. The council could advise the colleges in this work and suggest the names of persons and companies who are willing to co-operate in supplying material for this purpose.

(7) Attempt to have the standard engineering handbooks introduce a safety section to include safety codes and principles that apply to the particular branches of engineering which the handbook covers.

(8) The time is not yet ripe for the preparation of a college textbook on safety.

* Read before the conference of the engineering section of the National Safety Conference, Chicago, June 24.

Standardization of Shafting

The American Engineering Standards Committee has invited the American Society of Mechanical Engineers to act as sponsor for the standardization of shafting. The society has already done a considerable amount of work on a set of standard diameters for transmission and machinery shafting. It is proposed that the work, which will be carried out by a sectional committee working under the rules of procedure of the American Engineering Standards Committee, shall be broadened to include the standardization of the method of determining what diameters of transmission shafting should be used for given loads, the dimensions of shafting keys and keyways, and the setting of dimensional tolerances.

The Shipping Board Feels Its Way

BY WALDON FAWCETT

The temptation of the Shipping Board to await the forthcoming verdict of the country at large on legislative policies is the more readily understandable in the face of the expressed desire of the Board to work in sympathy and co-operation with the merchant marine committees of the United States Senate and House of Representatives. This spirit is exemplified in the handling of the question of American marine insurance. The Shipping Board is whole-heartedly behind the American marine insurance syndicates—the union of most of the existing American marine insurance interests—but is further pressing the issue on the theory that various legislative disabilities must be removed ere American marine insurance companies can be placed on an equality with foreign competitors. To accomplish this will require action by various State legislatures as well as by the national legislature.

PROBABLY no man in the shipping and shipbuilding field, however impatient for the creation of a permanent American merchant marine worthy of the nation, expected that the announcement of a detailed program to this end would follow close upon the passage of the Merchant Marine Act. If there be any such, assuredly he has been doomed to disappointment, for the evolution of general policies is proceeding with the deliberation that is well nigh imperative in an undertaking of such magnitude. Formulation of policies and the inauguration of new activities have, by no means, waited upon the long deferred appointments to the Shipping Board, but two fundamental influences have counseled what might appear to an outsider conservatism and deliberation in the application of the new law designed to provide American instrumentalities for our water-borne commerce.

One restraining influence has been supplied by the circumstance that the new Merchant Marine Act is, as our readers doubtless appreciate, a voluminous and complex statute requiring careful study on the part of administrators in order that its provisions may be properly interpreted. At the headquarters of the Shipping Board the new law has been taken up section by section and carefully analyzed. The ambition has been to grasp, on behalf of the executives, not only the letter but likewise the spirit of the set of instructions furnished by Congress. This scrutiny, paragraph by paragraph, has naturally consumed considerable time. Indeed, it is only in the late summer of 1920 that we find the legal advisers of the Shipping Board ready to advise their principals as to how they may and should proceed under the authorization.

The Shipping Board Marking Time

Pending the determination of the all but judicial construction to be placed upon the diverse stipulations of the Merchant Marine Act, the Shipping Board has been compelled obviously to mark time. This influence, then, in behalf of deliberation has been an outside one, so to speak. It has been a necessity imposed upon the Board whatever its will to proceed. The other fundamental influence above referred to has been like in effect but of very different genesis. On this count we find the Shipping Board showing deliberation of its own volition.

To quote the words of a prominent executive, the Shipping Board is "feeling its way" not because it is in any doubt as to its objective, or is even hesitant as to the means that may best be employed to reach that objective, but simply by reason of uncertainty as to future external conditions that must inevitably affect the shipping and shipbuilding industries. There is not only a domestic transportation situation but a world condition to be taken into account in formulating a merchant marine program. The state of the money market, too, is calculated to have a bearing upon the employment of the national merchant fleet and the expansion of that fleet. And, finally—and most potently—the merchant marine program waits upon the outcome of the national elections in November, not so much because of the political element involved, strictly speaking, as by reason of the effect that election will have upon national policies and business conditions.

General Policies Being Evolved

In a nutshell, it may be put that the Shipping Board is working consistently and persistently to the evolution of general policies, but for the time being the disposition is to take decisive action only upon the propositions that require immediate attention to avoid loss or inconvenience. To the same end a sufficient-unto-the-day policy has been adopted. No issues are raised, but instead attention is confined to the issues that are thrust forward.

That the Shipping Board administration is not lacking in courage, however, nor in willingness to grapple with a situation that is menacing in any respect is attested by what has been done with wooden ships built during the war. In some respects it would have been the simple solution of a perplexing problem to have continued in operation the entire fleet of upward of three hundred wooden ships, even though it required a lavish use of public funds. The Shipping Board has not hesitated, however, as between the considerations of depreciation and operating expense. In consequence, we find more than one hundred of the wooden ships lying at anchor in the James River while scores of others are at various ports on the Atlantic Coast. The significant fact that not a bid was received when twenty-one of these vessels were offered for sale several months ago renders disquieting the whole problem of the wooden ships, but whether the only escape from the dilemna lies in the conversion of the wooden ships into barges for coastwise service or in some other equally drastic remedy the Shipping Board will not be disposed to temporize once its duty is clear.

Something of the same limitations that have operated to cause the Shipping Board to make haste slowly with its general policies have influenced the arrangements for the sale of surplus material, aside, of course, from the vessels. In the main, the sale of the surplus material has waited upon the completion of the surveys of material on hand. With the waning of summer the Shipping Board came into possession of preliminary surveys that will be used as a basis for a selling campaign, but the tentative surveys are subject to revision, with corresponding amendment of the sales programme. For the reassurance of the construction and supply branches of the industry it may be said that the Shipping Board officials promise, in planning the sales of surplus material, to be duly mindful of their moral obligation not to disturb the normal, rational market for marine equipment. In this respect the Shipping Board will have the benefit of the experience of the United States Army organization in disposing of its surplus property.

To Break Up Monopoly of Atlantic Seaports

In the expressions thus far made by Admiral Benson in hint of the governing policies that will actuate the Shipping Board, there is but one note that may savor of the radical in the estimation of some shipping interests. The innovation in question is that which promises "to break up the monopoly heretofore held by a few Atlantic seaports." It will be understood that the head of the Shipping Board has reference to shipping, not to shipbuilding, and he frankly ascribes whatever concentration exists to inadequate loading and unloading facilities at the neglected ports and to indifference on the part of the communities rather than to any ulterior motives on the part of the shipping interests that have "followed the crowd." Wherever lies the blame, the Shipping Board has voiced a determination to "spread the shipping." By so doing, it is argued, the development of the merchant marine will be stimulated and there will be afforded a measure of relief for the congestion of freight at railroad terminals, which "jam" of export shipments constitutes, just now, one of the gravest problems confronting business America.

That the policy which the Shipping Board is instituting in this respect bespeaks vision and imagination is attested by the appeal of Admiral Benson to American manufacturers to so route exports and imports that the facilities of the rail and water carriers of the United States can be used to the best advantage. It is the ambition of the Shipping Board to bring about a proper balance between rail and water carriers. The subject is intimately related, indeed, to the reform above mentioned which aims at the decentralization of American shipping. The theory of the Shipping Board is that there are certain zones of economic movement of exports originating upon rail lines, and if these zones can be made properly tributary to the logical outlets or ports of dispatch there will be created a form of harmonious team-play that will be the best augury of a noteworthy merchant marine.

Shipping Controlled by the Government

With the Shipping Board thus nominating policies that go to the very foundation of the American transportation structure, it becomes of interest what proportion of the shipping in commission is subject to the will of the Board. With this thought in mind, the latest figures are illuminating. The compilation of maritime resources, as of date of July 1, 1920, shows the Shipping Board in control of more than 50 percent of the tonnage and with almost the entire fleet, aside from a number of wooden vessels, in active service. The Shipping Board's holdings, on the date indicated, comprised 1,502 vessels of 6,238,948 gross tons or 9,358,421 deadweight tons. This total is to set over, for purposes of comparison, against the full strength of the sea-going merchant marine of the United States, which totals 3,404 vessels of 11,278,741 gross tons or 16,918,212 deadweight tons. The dominance of the Shipping Board on the side of the cargo carrying is indicated by the fact that of the 1,502 vessels owned and controlled by the Board on the date mentioned, 1,394 were cargo vessels, 27 were cargo and passenger vessels, 63 were tankers, 15 refrigerators and three transports.

One obligation to find itself on policy that will brook no extended delay, whatever might have been the desire of the Shipping Board, is that which involves the application of Section 28. This is the section of the Jones Merchant Marine Act of 1920 which is avowedly designed to prevent foreign shipping interests from discriminating against American vessels. It is claimed that foreign shipping interests, particularly those operating on the Pacific, have conducted an organized propaganda designed to discredit this feature of the merchant marine program and to arouse opposition, within the United States as well as outside, to Section 28. Thus challenged, the Shipping Board has declared that it will follow a policy for which, indeed, the law allows it no alternative, viz., strict enforcement of the discriminatory mandate, provided there be available ample tonnage under the United States flag.

Section 28 of the Merchant Marine Act

The discussion of the use of the powers vested in the Shipping Board and the Interstate Commerce Commission under Section 28 in the event that an attempt should be made, say, to divert Pacific commerce to Vancouver, British Columbia, has "cleared the atmosphere" with respect to one phase of Shipping Board jurisdiction that has occasioned some misunderstanding despite the apparent clarity of the enabling act. Admiral Benson, chairman of the Board, has taken occasion in his talks with interests that have been alarmed by threats of foreign retaliation to point out that neither the Board nor the Interstate Commerce Commission has authority to enforce the provisions of Section 28 as affecting the business of a foreign port or a port in a possession or dependency of the United States unless ample tonnage is available. Going farther, the Shipping Board head has accepted the construction which represents the Merchant Marine Act as concerned primarily with the conservation and continuation of United States shipping in American trades. To that end, American ships engaged in trade between foreign countries are given no advantages. The preferentials created by the recent action of Congress apply only to American ships operating between the United States and overseas ports.

In connection with the situation which has been precipitated by alien resistance to the "double standard" set up under Section 28, considerable interest may naturally attach on the part of shipping men to the distribution of the Shipping Board's fleet. By way of definite alien opponents engaged in the commerce of the western ocean, the Shipping Board has stated that when it has occasion to enforce Section 28 it will be prepared to supply any deficiencies in American tonnage in operation from Pacific ports in order that there may be no restriction upon the movement of American commerce. With that responsibility and others of like kind in mind, there is bound to be interest in the strategy which the Board shows in the disposition of its fleet.

Distribution of the Shipping Board's Fleet

At the beginning of the fiscal or official year only 16 percent of the tonnage controlled by the Shipping Board was in the trans-Pacific trade as compared with 39 percent in the northern European trade, 10 percent in the southern European, 11 percent in the South American, and 9 percent in the West Indian and Caribbean. In the allocation of the steel vessels engaged in these services we find much the same proportionate balance of strength. To be specific, 615 of the steel vessels are operating from north Atlantic ports, 62 from south Atlantic ports, 184 from Gulf ports and 113 from Pacific ports.

The Shipping Board will be in the better position to turn, if need be, energetically to the development of a governmentally-sponsored merchant marine on the tran-Pacific routes now that it has well in hand its first labor of love in behalf of the extension of Yankee trade, viz., the provision of direct service between the United States and Latin-American ports. By recent inventory, the Shipping Board has in trade between this country and ports in Central and South America forty-one direct service lines employing 134 cargo vessels of 860,180 deadweight tons. Naturally, the bulk of the traffic is found, at least for the time being, on the trade lanes extending from United States Atlantic and Gulf ports to the east coast of South America. On these routes the Shipping Board has in operation 23 lines enlisting 94 vessels of 648,504 deadweight tons. From Atlantic and Gulf ports to the west coast of South America, 10 direct service lines are operating 28 vessels of 151,686 deadweight tons. From the Pacific Coast of the United States to the east coast of South America—an important innovation—the Shipping Board has inaugurated a line that is operating two vessels of 15,000 deadweight tons. And from the Pacific coast the Board is operating to the west coast of South America four direct lines engaging four vessels of 21,800 deadweight tons.

Whatever responsibilities or complications may result from the enforcement of Section 28—"the teeth" of the Merchant Marine Act, it has been characterized—are presumably postponed, however, until after the first of next year. This is the consequence of the action of the Shipping Board in certifying to the Interstate Commerce Commission the desirability of extending until January 1, 1921, the period of suspension of the provisions of Section 28. The Board came to the conclusion that the 90 days' suspension heretofore in force is not sufficient for proper inquiry into the subject and that it will be the first of the year ere it can make intelligent application of the provisions which prevent American railroads from making preferential rail rates for commodities moving in import or export except when moved in American ships. Postponement until the new year will, it may be appreciated, allow the Shipping Board to follow its impulse to hold back in so far as possible on the formulation of policies until after election and the reassembling of Congress and, incidentally, to co-ordinate its policies on all the most important questions before it. It will also give new members of the Board a voice in shaping its policies.

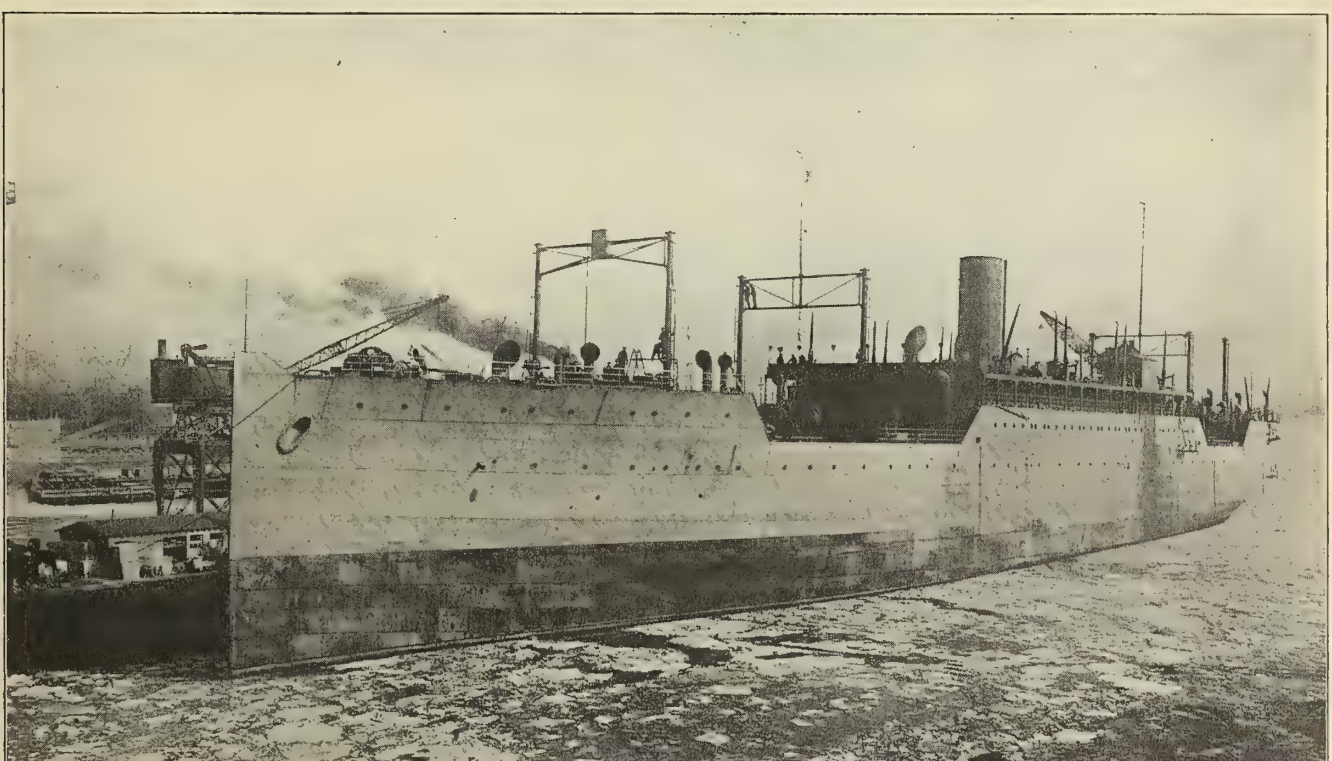
Troopships Completed at Hog Island

Description of 6,000-Horsepower, General Electric Geared Turbine Installations on Vessels to Be Used in Philippine Trade

THE first of the twelve troopships being built by the Government at the Hog Island yard recently made her trial trip, developing an average speed of 16.75 knots for four runs. These vessels, which are to be used between the United States and the Philippines, are all of one type. The main dimensions are as follows: Length between perpendiculars, 448 feet; beam, 58 feet; draft, loaded, 28 feet 3/4 inch.

The vessels are equipped with 6,000-horsepower marine geared turbines, furnished by the General Electric Company of Schenectady, N. Y., being among the 122 vessels built at the Hog Island yard since its establishment, all of which have been equipped with General Electric marine geared turbines.

The propelling machinery, designed to give the ship a speed of 15 knots, consists of a cross-compound Curtis



U. S. S. *St. Mihiel*, Equipped With General Electric Geared Turbine of 6,000 Horsepower steam turbine, which is divided into a high pressure and low pressure section, and a set of double reduction, twin drive, one plane, speed reducing gears. The turbine delivers its contract full power at a speed of 3,836 revolutions per minute for the high pressure section and of 3,428 revolutions per minute for the low pressure section. The reduction of speed from that of the turbine to that of the propeller is accomplished in two steps. The total speed reduction from the turbine speed of 3,836 revolutions per minute and 3,428 revolutions per minute to the gear or propeller speed of 100 revolutions per minute gives a ratio of 38.36 to 1 and 34.28 to 1, respectively.

The direction of rotation of the turbine wheels for both the high pressure and the low pressure sections is clockwise, or right hand, when viewed from the after or gear end.

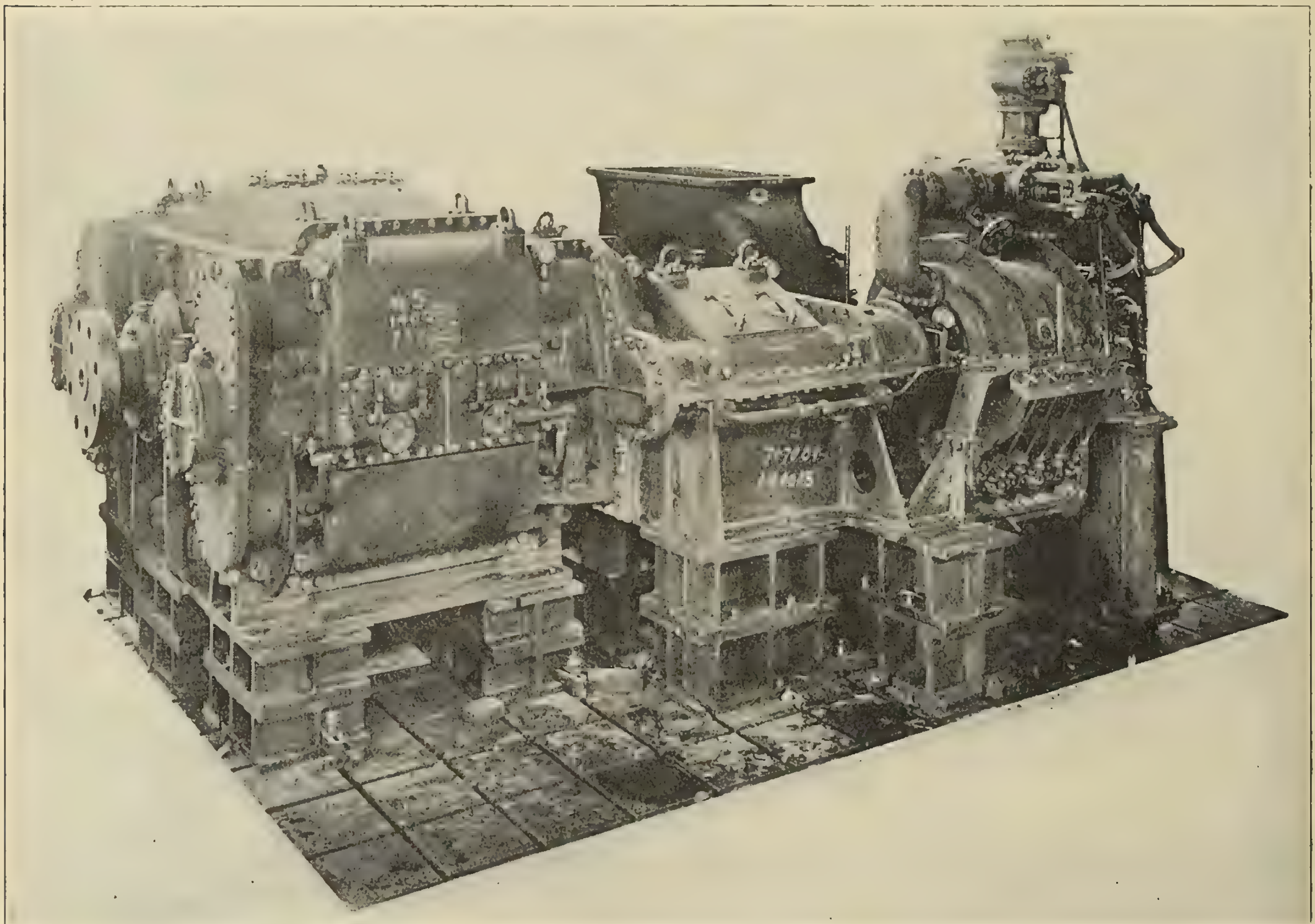
The direction of rotation of the low speed gear and propeller shaft is counter clockwise, or left hand, when viewed from the after end.

Turbine

The turbine consists of two parts, a high pressure and a low pressure section, located on the starboard and port sides of the ship respectively. The sections can propel the ship independently of each other, in case of a breakdown of one section. They are arranged in separate casings, with the rotor of each connected to a separate pinion. Each section consists of three stages ahead and one stage astern, embodying an ahead and an astern element, which are both carried on one shaft in one casing. Full power is delivered at a steam pressure of 185 pounds, the steam being superheated 75 degrees F. and exhausting into a vacuum at 28.5 inches.

Each turbine section develops one-half of the full contract power for running ahead. The astern power developed is two-thirds of the full ahead torque.

The turbines follow closely the design of the 2,500-3,000 horsepower General Electric marine geared turbine which has given excellent service in cargo boats. Steam is admitted through the combined strainer and emergency valve into the ahead or astern steam bowl of the high-pressure section, passes through the stages of this section and is led through the cross-over connection to either the ahead or astern steam bowl of the low pressure section and exhausts into the condenser. In case of overspeeding of the unit, or in any other emergency case, the steam is shut off by an emergency valve connected to the emergency tripping device.

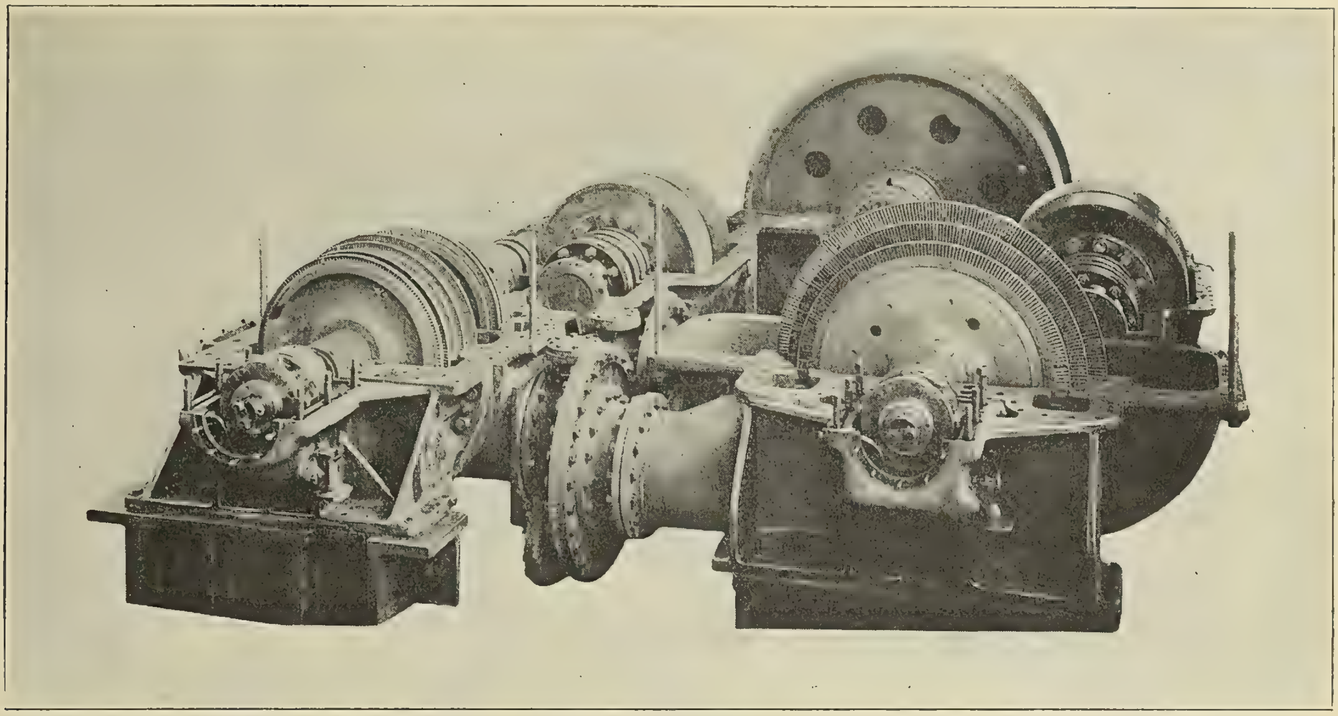


Starboard View of 6,000-Horsepower Geared Turbine Marine Unit, Looking Inboard

The balanced, horizontal spindle, maneuvering valve directs and controls the steam to the ahead and astern elements of the turbine, the hand levers being so interlocked that only one of the valves can be opened at a time. In addition there are installed two hand valves for further controlling the steam supply to the first stage nozzles of the high pressure section when less than full speed is desired. Leakage of steam to the astern element is prevented by a guarding valve.

The connection between the turbine shafts and the high speed pinions is established by pin couplings, allowing free axial movement of the gear elements.

An emergency governor is fitted to the forward end of each turbine shaft, and a tripping device is installed to

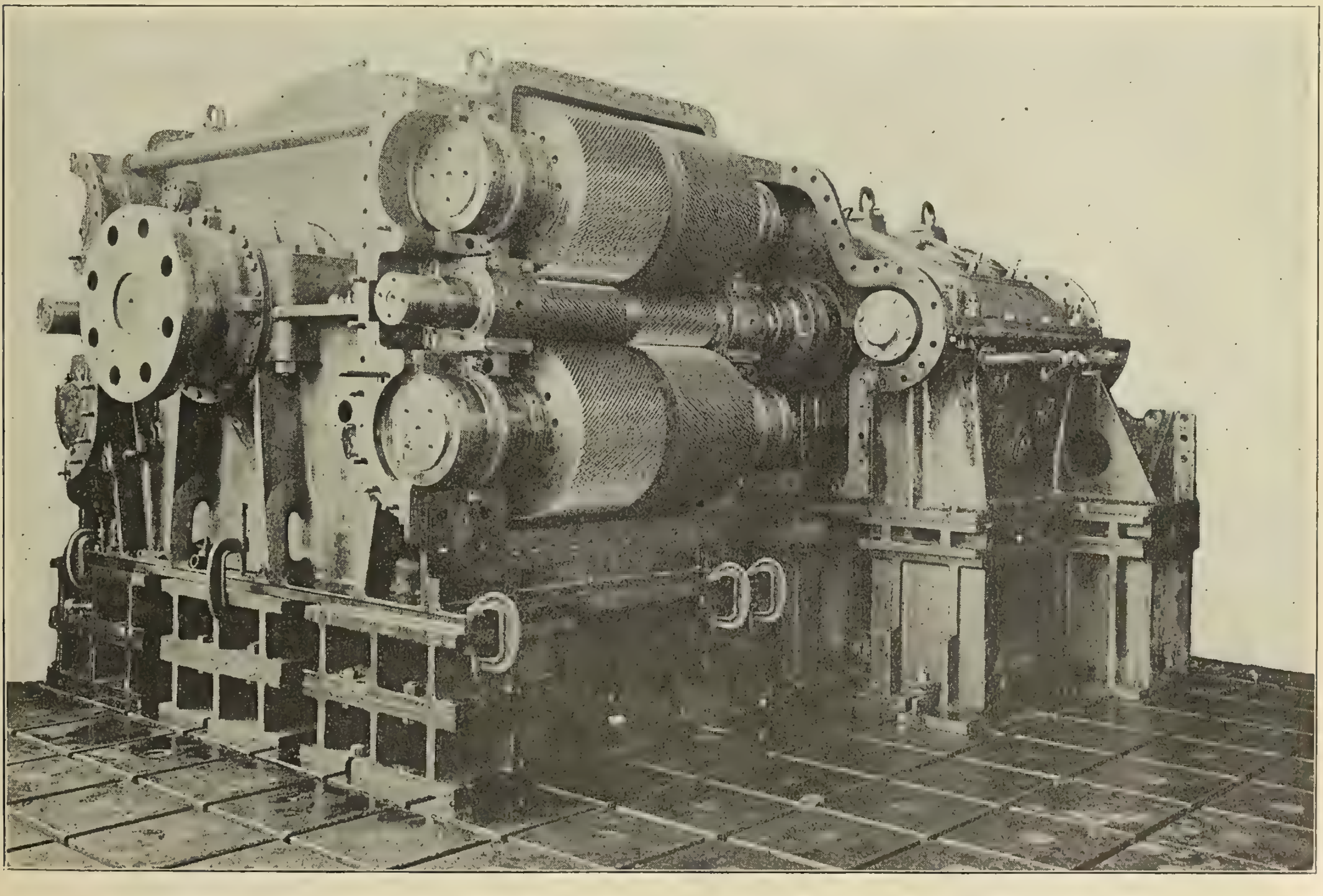


Upper Halves of Casings Removed on 6,000-Horsepower Marine Turbine Unit, Showing Rotors in Position

safeguard the unit by automatically shutting off the steam, if the machine should over speed, or the lubrication system should fail to function.

The cross-over connections between the two turbine sections are constructed to permit the engineer to make the steam supply connections so as to operate either section separately, in case of emergency.

The speed reducing gears are mounted directly abaft the turbine and are divided into two elements, a high speed element and a low speed element. The high speed reduction consists of two parts, in two separate casings, one of which is bolted to the low pressure, the other to the high pressure section of the turbine, while the low speed gears are contained in one casing, the frame being con-



6,000-Horsepower Marine Gear With Side of Main Gear Casing Removed, Showing Pinion Gear Idlers tinuous for the turbine and gears, making a complete unit.

The high speed reduction consists of a flexible high speed pinion and a flexible high speed gear. The high speed pinions consist of three parts—the flexible shaft, which is coupled to the turbine shaft, the quill pinion, and the coupling connecting the flexible shaft to the quill pinion.

High Speed Reduction

The high speed gear wheels are of the alquist flexible disk type and are built up from a number of disks which are mounted on, and firmly bolted to, the middle flange of the hub, dividing the gear into two halves. The disks are separated by a small clearance space at their peripheries and are capable of axial deflection, which insures an equal distribution of load over those parts of the teeth in mesh.

Low Speed Element

The low speed pinions have teeth machined on the peripheries and are connected to the high speed gears by solid flanged couplings.

The low speed gear wheel is a strongly ribbed casting, with the rim turned and grooved to receive the gear blanks. The wheel is pressed and keyed on the shaft.

Lubrication

The bearings of the turbine and the gears, the gears, the pin couplings, the thrust bearings, etc., are lubricated from the main oil circulating system of the ship.

Bulk Cargo Handling on the Atlantic Coast

Improved Machinery, First Developed on the Great Lakes, to Be Adapted for Handling Bulk Cargoes at Atlantic Ports

IN the past four years several factors have caused a stimulation of interest among shippers of heavy bulk materials in a cheaper and more rapid scheme of handling such commodities. The manufacturers of apparatus, especially the pioneers in this line, started a movement in this direction some twenty years ago and succeeded in getting a limited number of plants installed as early as 1902. The development of plants for handling large tonnage of coal and iron ore was the most obvious necessity, and it was naturally the first problem attacked on a large scale.

The necessity for such development centered around the Great Lakes region, and the pioneer installations were put in in this vicinity. The short season of navigation from the Minnesota, Wisconsin and Michigan ore fields to the blast furnaces of the lower lakes and the Pittsburgh district requires a movement of twelve months' supply of ore in about seven months. The coal supply of the states bordering on the iron ore region was largely taken from the lower lakes on the return trip of the ore boats. In order to perform this task with the minimum of equipment and operating costs per ton, it was plainly necessary

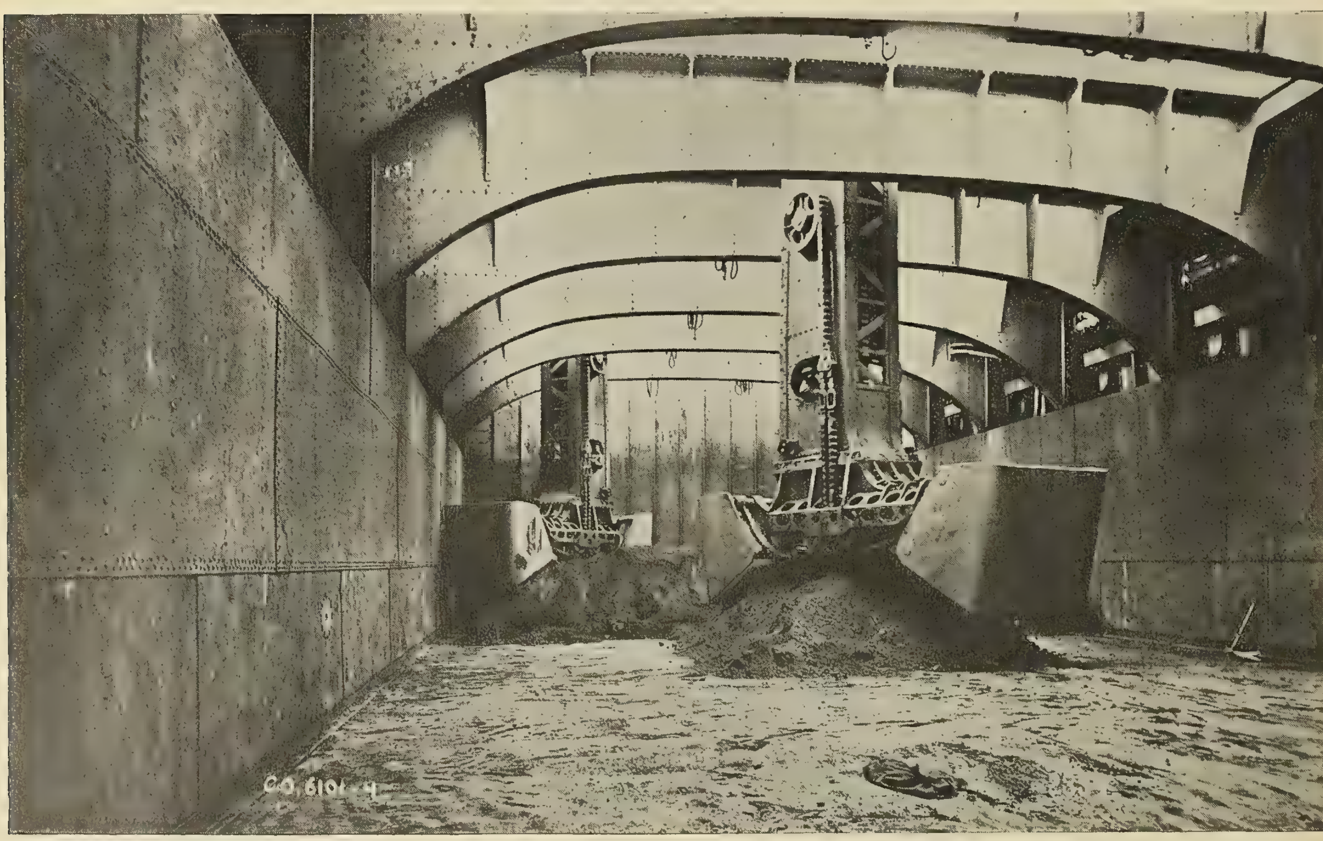


Fig. 1.—Unloader Leg and Bucket of a Wellman-Seaver-Morgan Unloader at Work in the Hold of a Modern Boat

The leg is so mounted in the walking beam that it can rotate in a circle, allowing the bucket to reach out in all directions. These machines have often unloaded 97 percent of a cargo without the help of shovelers. The position of the operator who controls the movements of the bucket is shown above. The distance from point to point of the bucket shell when open is 21 feet.

Fig. 2.—Wellman-Seaver-Morgan Unloader Installed at the Docks of the United States Steel Corporation, Conneaut, Ohio. There Are Seven of These Unloaders Installed at This Plant, Some of Which Are Shown in the View Above

to provide machinery for cheap and rapid discharge of cargo from ship to dock or railroad and vice versa, the length of time the ship was tied up to the dock being a vital factor in costs. The result has been a high state of development and concentration of bulk cargo handling plants in the Lakes region.

First Ore Unloaders Installed on the Lakes

In the late nineties the Wellman-Seaver-Morgan Company, Cleveland, Ohio, brought out their ore unloader, each machine capable of handling ore at from 500 tons per hour upward. At about the same time the car dumper, for overturning standard railway cars and dumping their contents, was developed. The latter have been evolved until at present they will handle 30 dumps per hour and upward, some installations handling as much as 3,000 tons per hour of net material, two cars in tandem.

Conditions largely due to the European war caused a more general interest to be developed along our coast line in these methods. Prior to our participation in the war a few installations had been made on the Atlantic Coast, especially in the line of loading cargo and bunker coal. Rising labor costs and necessity of rapid *turn around* on the comparatively few vessels available brought the issue of improved dock facilities to the forefront. It was a question of time, tonnage capacity over a given waterfront, and costs per ton. All the above items in the problem are satisfactorily answered by equipment of the type previously mentioned, and what was still more vital the item of labor in normal volume being unobtainable at any price.

Two Contracts Closed on the Atlantic Coast

Two contracts recently secured by the Wellman-Seaver-Morgan Company on the Atlantic Coast are interesting at this time. A contract with the Lehigh Valley Railroad Company covers an automatic ore unloader carrying a fifteen-ton clam shell bucket on the unloader leg and designed to make a complete cycle or round trip in 50 seconds. The machine electrically operated throughout is illustrated by Fig. 1, and this view, together with Fig. 2, illustrates the general appearance of similar apparatus in action.

The automatic unloader illustrated is unique in design and has proved through many years of service to be eminently successful for unloading ore cargoes from steamers with suitable hatches. Although of immense proportions, the machine has been simplified and the control perfected to a high degree of delicacy in control and operation.

Description of the Unloader

The unloader consists of a main framework mounted on trucks which travel along the runway rails, which are located approximately as shown in the photograph. The main framework extends back beyond the rear runway over a temporary storage pile, where the ore can be discharged if desired. It is then picked up by the ore bridge and carried to the stock pile. Between the front and rear runways, space is provided for railroad tracks where ore carrying cars are placed under the machines and loaded with ore for transportation to the furnace plants. The girders of the main framework form a support for runway rails, on which a trolley travels. This trolley supports a balanced walking beam, from the outer end of which a stiff bucket leg depends. At the lower end of thi leg is the bucket, which is operated by machinery located on the walking beam. All horizontal movements of the bucket are accomplished by means of moving the trolley backward and forward on the girders. The vertical movements of the bucket are accomplished by the operation of the walking beam. The forward portion of the beam being out of balance, the bucket descends by gravity as soon as the brakes of the hoisting mechanism are released.

Only two operators are required for the entire operation

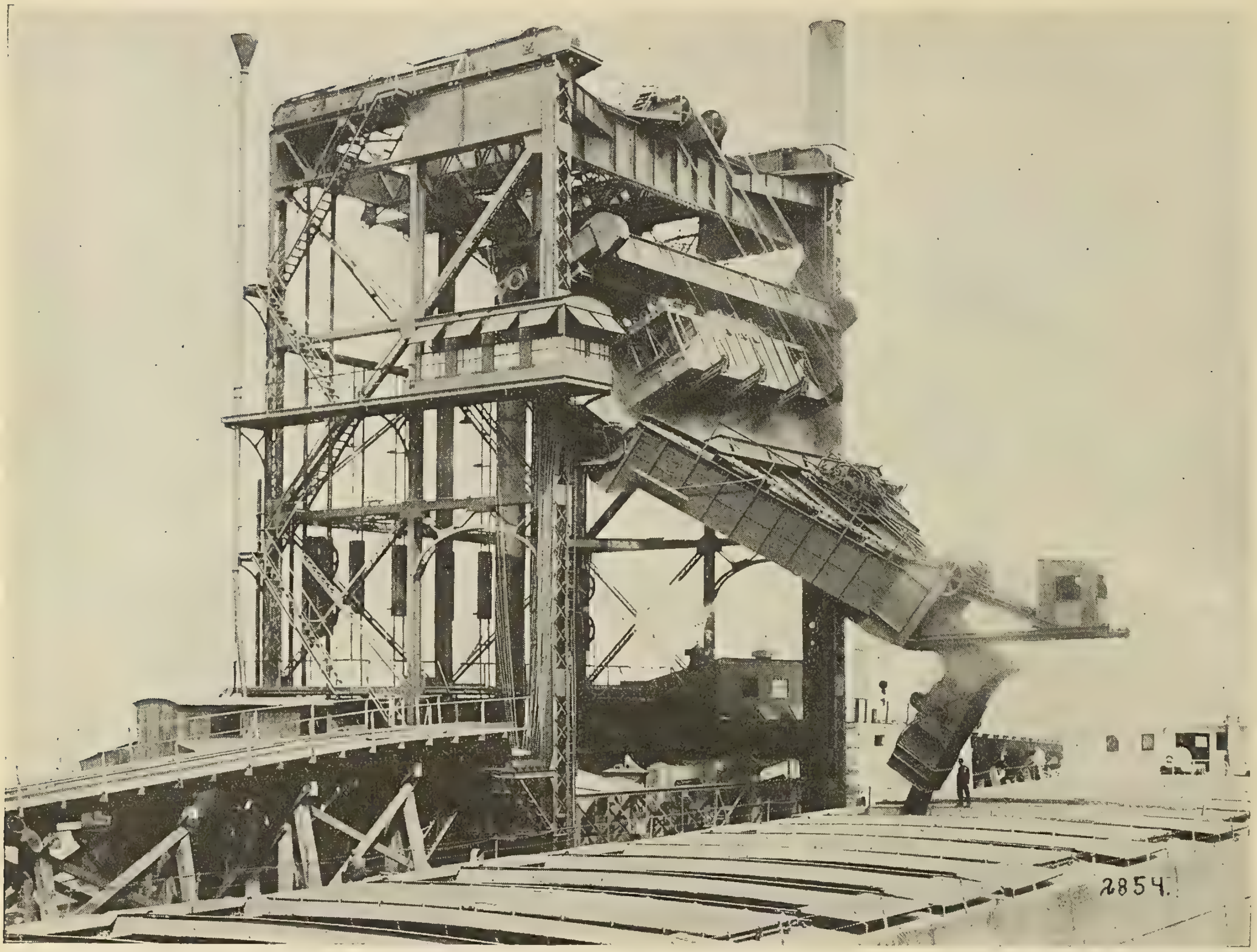


Fig. 3.—Wellman-Seaver-Morgan Lifting Type Car Dumper on the Docks of the Pennsylvania Railroad at Sandusky, Ohio. The Cradle, Containing Car to Be Dumped, is Elevated Before Being Overturned. The Coal is Emptied Into an Adjustable Apron and Chute, Which Are so Designed as to Load the Coal Into Boats With a Minimum of Breakage

of one of these machines. One of the operators, whose station is in the bucket leg directly over the bucket shells, controls all of the motions of raising and lowering the bucket, of traveling the trolley back and forth, and moving the machine along the dock from one hatch to another The second operator is stationed in a cab on the larry, and from this station he controls the movements of the larry, the operation of the larry gates, and the weighing of the ore.

Capacities Attained

Some idea of the capacities of unloading by this method may be derived from a record which was made in Ashtabula by eight machines of this type having a capacity of fifteen tons each, unloading seven boats having a total capacity of 70,000 tons in 22 hours actual time. At other points, four machines working in boats having capacities up to 13,000 tons have unloaded these cargoes in about three hours and twenty-five minutes.

In addition to the vertical movement, which is given to the bucket leg by means of the walking beam, it also has a motion of rotation around its vertical axis. This motion is introduced to enable the machine to reach along the keel of the boat and clean up ore between hatches. The distance from point to point of bucket shells when open is approximately 21 feet. About 97 percent of the ore is removed from the boat without hand labor.

Records of fifty machines in operation indicate that this type of machine will handle ore at 2½ to 4½ cents per ton including all fixed charges, and records of as high as 783 tons of ore per hour per machine from tie up to cast off of boat have been made.

The Lehigh Valley Unloader

The Lehigh ore unloader will be installed at the Claremont Terminals, New York Harbor, to handle Chilean and Cuban ore. A cost of pig iron lower than that based on Minnesota ore is predicted due to economies effected.

A contract with the Western Maryland Railroad Company at Port Covington, Baltimore, covers a Wellman car dumper to handle 100-ton road cars. It is the first electrically operated lifting dumper for seaboard coal loading to be negotiated. The lifting feature is designed to raise the road car high enough before overturning to cause the coal to run down the apron and chute into the ship's hold, as illustrated in Fig. 3. Dumping directly to the ship eliminates breakage and waste due to rehandling. The entire cargo is trimmed without the use of hand labor.

Car Dumper for Western Maryland Railroad

The machine consists essentially of a rectangular framework supporting a rotating cradle in which the loaded railroad car is held while discharging. An entirely automatic counterweight device clamps the car to the cradle which is inverted by the revolving mechanism, carrying the car with it. The top of the cradle forms a chute for directing the material as it flows out.

This installation will have a nominal capacity of 30 to 45 cars per hour of cargo and bunker coal, principally for export. The coal is delivered to the dumper by the Western Maryland Railroad from the West Virginia, Virginia and Pennsylvania fields. One million tons will be handled annually with a probable increase to twice that capacity later.

These typical plants indicate the essential soundness and progress of our basic industries, and the gradual elimination of hand labor, which is then diverted to more useful and productive work. These plans also indicate that beneath the surface froth of labor unrest and business uncertainty of the day there is a constant current of accomplishment and confidence. The former are merely the phenomena of a business cycle and the latter is the foundation of the country.

Westinghouse Geared Turbines Installed on New Swedish Battleships

EARLY in the coming fall Sweden will try out its two new coast defense battleships, the *Drottning Victoria* and the *Gustaf V*. These vessels are 396 feet long and 64 feet beam. At a draft of 21 feet they displace 7,000 tons and will have maximum speeds of 22½ knots. The main batteries consist of four 11-inch and eight 6-inch guns. The main armor belt is 8 inches thick.

The propelling equipment of each of these ships consists of two Westinghouse turbines, which are rated at 22,000 shaft horsepower and drive the two propellers through floating-frame reduction gears. The turbines were built in accordance with Westinghouse designs by the Motala Verkstads Nya Aktiebolag, at Motala, Sweden, and the gears were designed and built by the machine works of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa.

Each turbine consists of two separate units, rated at 5,500 shaft horsepower each, which drive a propeller through a common gear. Steam from the boiler enters the high pressure unit and passes through a set of impulse blades. It then divides into two parts, one of which continues through the high pressure unit, while the other goes into the low pressure unit. In both units the steam is fully expanded in reaction blading and passes into the condenser through a common discharge.

The chief advantage of this arrangement, which is known as the "divided flow," is that all four units are available for propelling the ship at maximum speeds; but for ordinary cruising speeds, the low pressure units can be cut out and the ship propelled by the high pressure units only. These, being of the complete expansion type, produce low speeds with good economy. Should an accident put a high pressure unit out of commission, the ship can be propelled by the low pressure units, which are designed to receive steam at boiler pressure. When any unit is out of use it usually turns idly in a vacuum, but it can be mechanically disconnected.

The divided flow turbine is not quite as efficient for full speed operation as the cross compound turbine, in which part of the expansion of the steam is effected in the high pressure unit and the rest in the low pressure unit. It is, however, more efficient at low speeds because one unit can be cut out, and this makes it especially applicable to naval service. In addition, it can be operated at somewhat

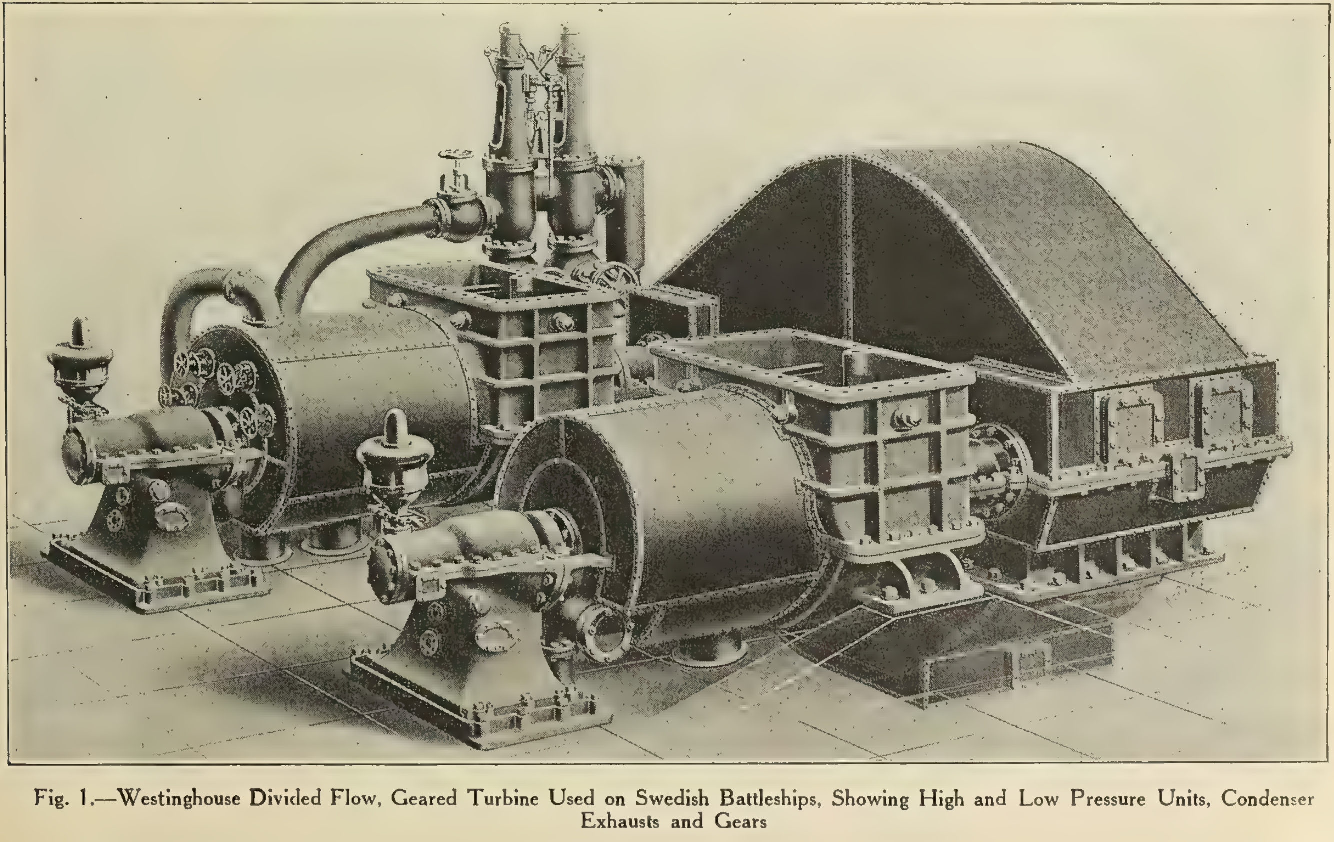


Fig. 1.—Westinghouse Divided Flow, Geared Turbine Used on Swedish Battleships, Showing High and Low Pressure Units, Condenser Exhausts and Gears

higher speeds, which tends to counterbalance its slightly poorer efficiency.

The performance of the Swedish turbines, with steam at 265 pounds per square inch and a vacuum of 28.27 inches, is as follows:

Speed, knots	22½	20	12½
Propeller revolutions per minute	200	177	115
Turbine revolutions per minute	3,600	3,186	2,070
Shaft horsepower	22,000	15,000	3,150
Steam consumption, pounds per shaft horsepower	10.9	11.1	13.3

The water rate at 12½ knots is for operation with the high pressure units only. Were all four units, lightly loaded, used to obtain this speed, the water rate would be about 17 pounds.

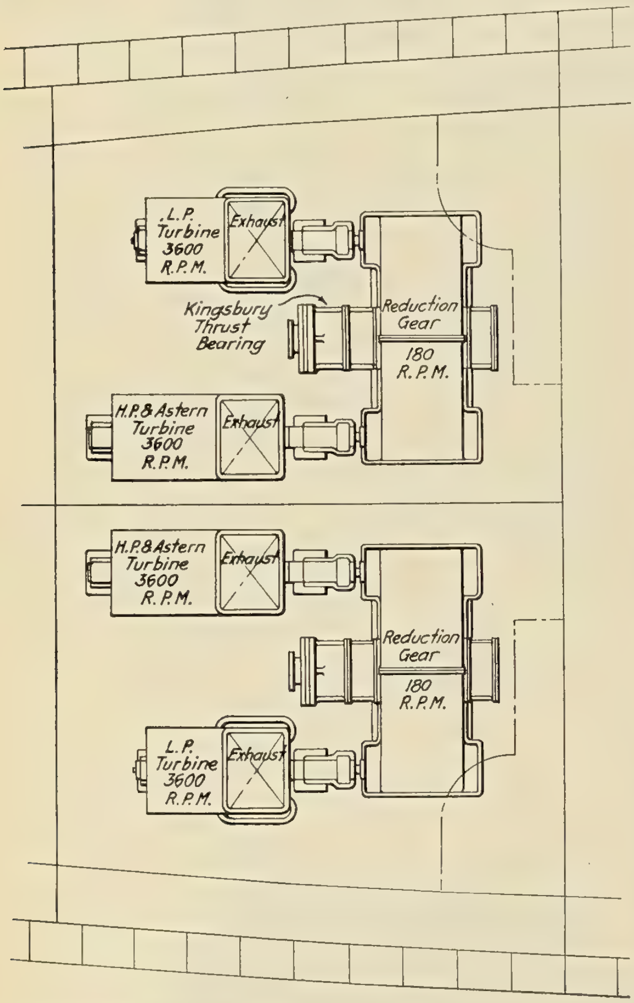


Fig. 2.—Arrangement of Machinery on Swedish Battleship

An astern turbine, composed of impulse blades and giving 4,500 shaft horsepower with full steam flow, is incorporated in each high pressure unit.

The reduction gears reduce the turbine speed of 3,600 revolutions per minute to the propeller speed of 200 revolutions per minute, an 18 to 1 ratio, in a single step. Each has two pinions (one for each unit of its turbine) and one gear wheel. The gears are placed forward of the turbines and the propeller shafts pass aft between the two units of each turbine. Kingsbury thrust bearings take up the thrust of the propellers.

G-R Strainer for Lubricating and Fuel Oil Lines

STRAINERS are required on the suction and discharge lines of lubricating oil, fuel oil and quenching oil systems for the removal of solid foreign material in suspension. Also power plants which secure their raw water supply from such sources as rivers or lakes require strainers to prevent weeds, sticks, marine plants and small fish from entering pipe lines. For this purpose The Griscom-Russell Company, 90 West street, New York, has placed on the market a G-R strainer, the body of which is constructed of cast iron and the strainer basket of perforated sheet steel lined with wire mesh when the strainer is to be used on an oil line. The G-R strainer is of the single type and may be installed either as a single unit or as the G-R strainer set. This G-R strainer set consists of two of these strainers connected complete, including the two 3-way valves and necessary connecting elbows, unions and nipples. This set permits the cleaning of either of the two units without interruption of the service. In addition to the oil strainer unit, the Griscom-Russell Company also produces a multiwhirl type cooler for cooling lubricating oils used in turbine bearings, reduction gears and similar heavy duty work. In this service the oil must be maintained at constant temperature as well as free from impurities.

G-R Strainer, Single Unit Construction

Welded Motorship Fullagar

(*Concluded from page 725.*)

extremely rough weather was encountered, and as this became worse it was found necessary to put into Ramsey until the storm abated. During this part of the voyage the engine ran steadily throughout, no racing being experienced, and there was only a slight variation in the revolutions. The hull was well tested, the force of the waves subjecting it to severe shocks and strains, which it withstood satisfactorily.

The vessel left Ramsey at 4:20 A. M. on July 1 and reached Greenock about 6 P. M. The engine continued to run steadily at a speed of 106 revolutions per minute, the ship making a speed of about 9.75 knots against wind and tide.

On July 2 a party of Clyde shipbuilders and engineers were present and witnessed trial runs on the measured mile, and also maneuvering tests. The *Fullagar* left the Clyde at 11:30 P. M. on the same evening and arrived in the Mersey at 8 P. M. on July 3. The engine ran satisfactorily and without any sign of trouble from start to finish at an average speed of 107 revolutions per minute, the vessel averaging about 10 knots. During this run the fuel consumption worked out to be 2.1 tons per day of 24 hours.

Some of the readings from the engine are as follows:

Scavenge air pressure	1¼	pounds per square inch
Circulating water pressure	6.5	pounds per square inch
Lubricating oil pressure	12	pounds per square inch
Blast air pressure	1,000	pounds per square inch
Scavenge temperature	50	degrees F.
Circulating discharge temperature	100	degrees F.
Engine room temperature	62	degrees F.

Experience and Practice in Mechanical Reduction Gears in Warships*

BY ENGINEER-COMMANDER H. B. TOSTEVIN, D.S.O., R.N.

The most important change in the steam machinery of warships of high speed and power during the war period was the departure from the direct drive turbine installation to that in which the power of the turbines was transmitted to the propeller shaft through mechanical reduction gearing. It is the object of this paper to trace briefly this development and indicate the experience that has been gained and also the general practice of the British Admiralty as regards the details of these gears.

BEFORE the actual adoption of gearing it had long been recognized that some form of reduction device was necessary in order that the turbines and propellers should run at speeds which secure their best efficiencies, and all designs with the direct drive installations had been of the nature of a compromise in which the maximum efficiencies of both turbines and propellers had been sacrificed in order to obtain the best overall results to meet the nature of the particular case. There were three practical methods of obtaining this reduction, viz., hydraulic, electrical and mechanical, each possessing its peculiar merits, and in the early history it is noteworthy that the first two were more seriously considered than the third, as they did not at the time offer such difficulties in the way of manufacture and reliable transmission of high power. At the present stage in British naval practice the first two methods have not been tried, at least in connection with high power steam machinery.

Whatever method is adopted, a loss must occur between the turbines and the propeller shaft from various causes, which need not be gone into here. Experiments have shown that with the best design of the respective devices the losses in transmission may be approximately taken as: hydraulic, 10 percent; electrical, 8 percent; mechanical gearing, 1½ percent. If double reduction gear were fitted, the loss with mechanical gear would be about 3 percent.

The superior efficiency of the mechanical method has been an important factor in reaching a decision as to the type of reduction device to be adopted for naval use, and when it is combined with considerations of simplicity and reliability and the very small cost of upkeep, the combination has been considered up to the present to outweigh the advantages possessed by the other forms of transmission, such as the absence of astern turbines and the possible maintenance of a higher turbine speed and efficiency at cruising speeds. With the design of turbine as now developed, in which special arrangements are made to permit it to maintain its efficiency to a marked extent as the speed of revolution falls, this latter advantage is to a certain extent discounted.

The endurance and reliability which are features of turbine installations are even more pronounced when geared turbines are fitted, because of the smaller and more rigid structures and moving parts. Also, the larger and more efficient propellers improve the maneuvering power, and in particular the stopping effect is increased by the ease with which the larger propellers get a hold on the water. The necessary astern power (which in most warships is approximately one-third of the ahead power) can be obtained on a single velocity compounded turbine wheel without working the boilers to full power. The smaller turbines and their more substantial construction render them less liable to distortion troubles than is the case with the larger direct connected units.

To trace the development of mechanical gearing for marine purposes one need go back no further than 1910, when Sir Charles Parsons, who was desirous of applying the steam turbine to vessels of moderate and low speed, carried out his experiments in the *Vespasian,* an old cargo steamer, experiments which have proved to be epoch-making. The success of these experiments, which were dealt with in a paper read before this Institution in 1910,† indicated that increased efficiency could also be obtained by means of reduction gearing in ships of the classes from which the reciprocating engine had been definitely displaced by the turbine. The Admiralty made its first step in 1910, and in two topedo-boat destroyers of that year's programme, the *Badger* and *Beaver,* gearing was fitted for part of the main turbine installations. The low pressure turbines drove the shafts direct, but on a forward extension of their rotor spindles gear wheels were fitted which were driven through pinions by the small fast running cruising and high pressure turbines. The maximum horsepower transmitted through each set of gearing was about 3,000. Before these vessels were completed a further advance was made, and in 1912 it was arranged, in two torpedo-boat destroyers, the *Leonidas* and *Lucifer,* of 22,500 horsepower, for the whole power to be transmitted through two sets of gearing. The general arrangement as regards the component parts of an all-geared set adopted in these vessels has been adhered to in naval practice to the present day, viz., each set of gearing is driven by two pinions, driven respectively by the high pressure and low pressure turbine. In some installations an additional turbine for cruising has been fitted on an extension of the high pressure spindle.

On completion of the *Leonidas* in 1914 exhaustive trials were carried out, and the results obtained as regards the efficiency of the machinery installation at all powers were very satisfactory and superior to any that had been obtained with direct drive units. Both vessels were hurriedly put into commission in August, 1914, when experience with the running of high powered gears was practically nil. The installations received a very severe test on service, as both boats were in commission right through the war, for the first two years being attached to the hard-worked Harwich force. Their successful running speaks volumes for the manner in which several recognized difficulties connected with the application of mechanical reduction gears for high powers had been so quickly recognized and overcome.

Before the completion of the *Leonidas* and *Lucifer,* two light cruisers of 40,000 horsepower, viz., *Calliope* and *Champion,* were arranged to have all geared units, but

* Paper read before the Institution of Naval Architects, London, March 26, 1920.

† Transactions, Institution of Naval Architects, Volume LII, page 168

the former vessel was fitted with four shafts and the latter with two, so it is seen that in the course of three years from the adoption of reduction gearing, and in the third order of warship so fitted, a figure of 20,000 horsepower through one set of gearing was reached. This installation ran satisfactorily on service, and as a result it was recognized that mechanical gears were suitable for the highest power required on a single propeller shaft.

The all-geared installations were not at once universally adopted for the vessels ordered on the earlier war programmes, the policy in the emergency of adhering to the direct drive type of turbine, which for several years had proved its efficiency and reliability, being followed for some time. The subject of gearing was, however, by no means ignored, and all warships ordered were fitted with cruising turbines, which were geared to the direct drive units. Clutches were arranged to disengage these gears when running at high powers, although this procedure was not absolutely necessary. A marked gain in economy within the limits of power of the cruising turbines, and a consequent increase in the radius of action was obtained. It should also be understood that at this time the number of special "hobbing" machines required for cutting the teeth of these gears was very limited, and it would not have been possible at the time to have fitted all the war vessels ordered with the all-geared type of installations. By 1916, however, it was considered that sufficient progress had been made to warrant the complete change over, and in practically all fast warships, viz., battle cruisers (a number of which were subsequently not proceeded with) designed to transmit 36,000 horsepower through each set of gearing, light cruisers, flotilla leaders, torpedo-boat destroyers, "K" class submarines, and "P" boats, the all-geared installation was adopted. Only in the case of a few special destroyers was the direct drive adhered to.

The following table shows the total horsepower and number of all-geared sets fitted and being fitted in warships:

Type of Vessel	Shaft Horsepower	Number of Shafts	Shaft Horsepower per Gearing Set	Total Number of Gears	Total Shaft Horsepower
Battle cruiser	144,000	4	36,000	4	144,000
Light cruisers	40,000–80,000	2 or 4	10,000–20,000	50	1,760,000
Flotilla leaders	40,000	2	20,000	26	520,000
Torpedo-boat destroyers	27,000–30,000	2	13,500–15,000	368	5,000,000
"K" Class submarines	10,000	2	5,000	36	180,000
"P" and "P.C." boats	3,500	2	1,750	128	224,000
Totals	......	....		612	7,828,000

Of this number, 556 gears are, or have been, on service, representing 6,794,000 shaft horsepower. The 36,000 shaft horsepower sets have not yet been on service, but have run at approximately full power for a short period.

In addition there are a large number of sets of gears fitted in conjunction with cruising turbines, or as part installations, but as these gears, owing to the exigencies of war and other conditions, have not been used to their full extent, they are not included in the list.

The arrangements of turbines and gearing in typical vessels are shown in Figs. 1 to 8.

In straight cut gears the small number of teeth in contact, viz., one or two, imposes a limit to the speed at which high powers can be smoothly or safely transmitted, and for transmitting high power, helical gear, i. e., toothed wheels in which the teeth are inclined to the axes of the wheels, is necessary. All the gearing now in use in warships is of the double helical type, a right and left hand helix being used to balance the axial thrust entailed. The involute tooth form is invariably used, as it possesses essential advantages over other forms, the most important of which are:

(1) The teeth can be generated automatically in a machine by a straight sided cutting tool, which can be made and ground very accurately.

(2) A variation in distance between the centers of pinion and wheel (and such variations occur in marine practice owing to the necessity for ample clearance in the high speed bearings, and also possibly with misalinement and wear of bearings) does not affect the velocity ratio of the wheel and pinion or the smooth working of the teeth.

In the early days of turbine gearing there was not much experience available bearing on helical gearing for comparatively high powers, and in the first designs the gears were arranged with a helical angle of 20 degrees in conjunction with a pitch normal to the line of the teeth of ¾ inch. This design was rather noisy, and in consequence the angle in succeeding designs was increased to about 45 degrees, which value was known to have proved satisfactory in DeLaval installations of small power. The 45-degree design was continued until recently with generally satisfactory results, but in the meantime, with the improvements in gear cutting processes, it had gradually been established that the noise and tremor experienced in the early installations was more due to irregularities in cutting than to the small helical angle itself. An angle of 30 degrees, which possesses advantages in the way of efficiency and tooth strength, in that the effective contact between the teeth is increased as compared with 45 degrees, while the normal load on the teeth is decreased, has now been generally adopted by the Admiralty. This angle is rarely an exact number of degrees, as it is affected by the driving and change wheel mechanism of the hobbing machine, but is as near the desired angle as these details allow.

The angle of obliquity used is 14½ degrees, in agreement with the almost universal commercial standard developed for spur gearing with involute teeth. There is no particular virtue in this angle within limits, and the odd ½ degree, it is understood, was decided by the fact that sine 14½ degrees being 0.250, calculations were simplified.

Fine pitched gears give more silent running at high speeds, and a normal pitch of 7/12 inch has been adopted for all but the very largest installations. While the pitch and obliquity have remained the same, the proportion between addendum, dedendum and pitch respectively and the shape of the root and tip have been changed from time to time as experience of the successive designs was gained. Fig. 9 illustrates stages of the transition, it being noted that the form of cutting tool is shown, and that while the height and normal pitch of the actual tooth generated will be the same as for the hob, the thickness and contour of the teeth will depend upon the pitch circle diameter and upon the hob design. The earliest design of hob (which is not shown) produced a form which gave at the base of tooth only a small radius, and it was at a very early stage modified to provide a more pronounced radius at the tooth root. In the design in Figs. 9*b* and 9*c* the rounding of the tips of the teeth was introduced to overcome the "digging in" and excessive wear of the tips which had been observed in some designs, probably due to the failure of the oil film on the surface at this position.

The question of the lubrication of the teeth is very important, and while running an ample amount of oil, which is generally injected from nozzles onto the line of contact of the teeth, is necessary. It is usual to arrange ¼-inch to ⅜-inch nozzles of about 5-inch pitch, discharging the

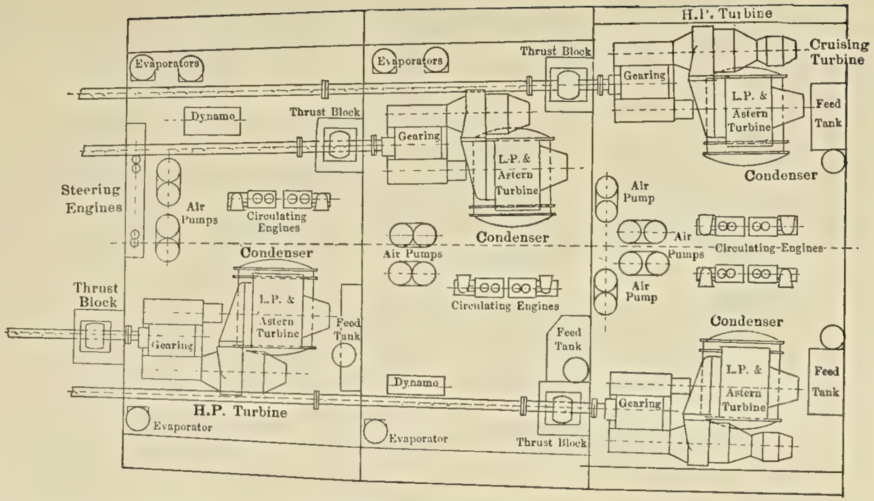


Fig. 1.—Plan of Machinery Installation, Battle Cruiser. Total Shaft Horsepower, 144,000; Revolutions of Propeller Shafts, 210; Revolutions of High Pressure Turbines, 1,497; Revolutions of Low Pressure Turbines, 1,096

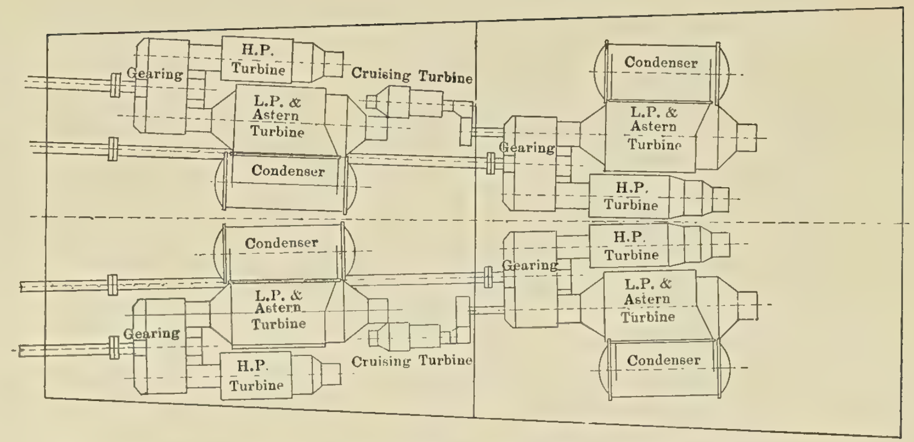


Fig. 3.—Arrangement of Turbines and Gearing, Light Cruiser (H. M. S. *Calliope*). Total Shaft Horsepower, 40,000; Revolutions of High Pressure Turbines, 3,000; Revolutions of Low Pressure Turbines, 1,750; Revolutions of Propeller, 450

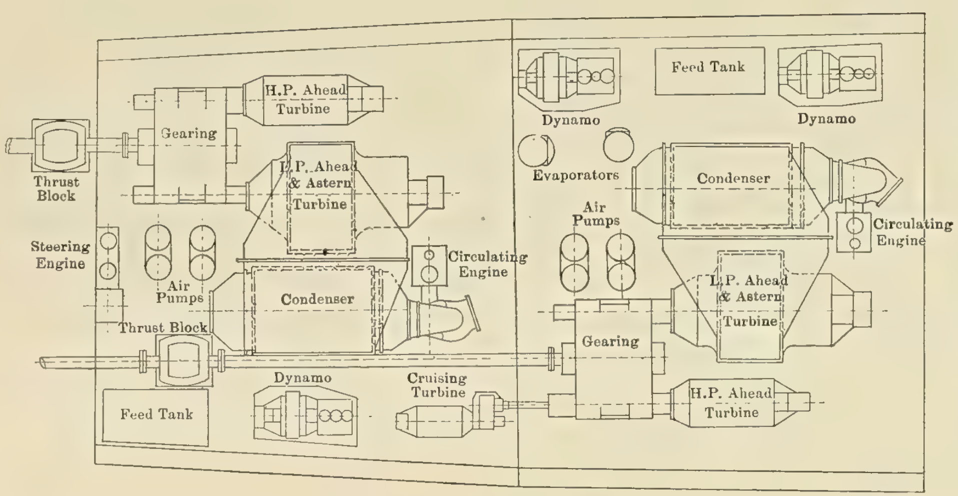


Fig. 2.—Plan of Machinery Installation, Light Cruiser. Total Shaft Horsepower, 40,000; Revolutions High Pressure Turbines, 2,600; Revolutions Low Pressure Turbines, 1,435; Revolutions Propeller Shafts, 340

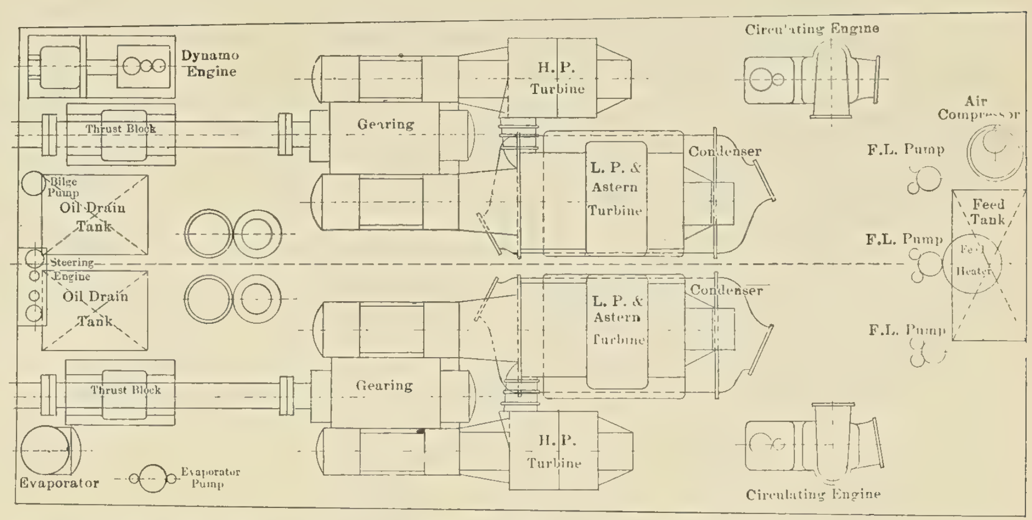


Fig. 4.—Plan of Machinery Installation, Torpedo Boat Destroyer. Total Shaft Horsepower, 27,000; Revolutions of High Pressure Turbines, 2,985; Revolutions of Low Pressure Turbines, 2,262; Revolutions of Propeller Shafts, 350

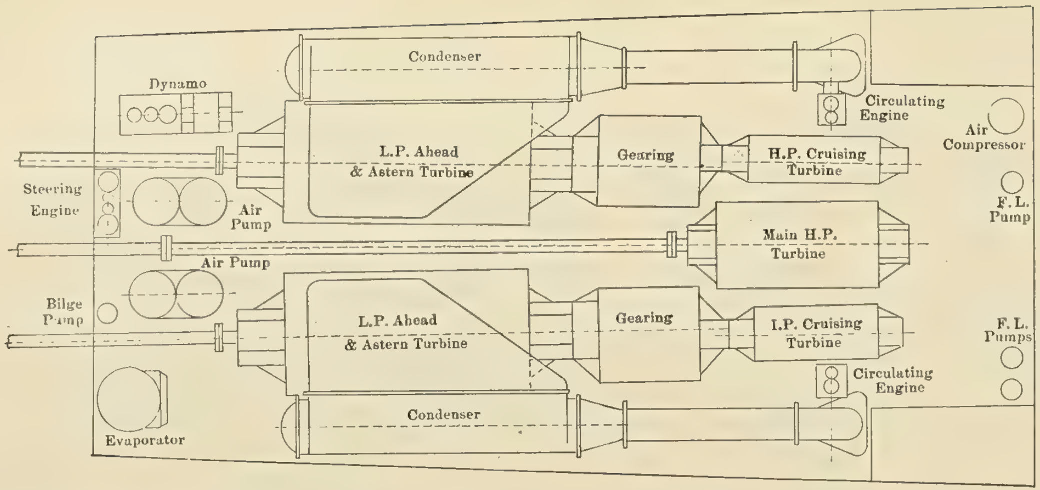


Fig. 5.—Plan of Machinery Arrangement, Torpedo Boat Destroyer With Geared Cruising Turbines. Total Shaft Horsepower, 25,000; Revolutions of High Pressure and Low Pressure Turbines and Propeller Shafts, 750; Reduction Ratios: High Pressure Cruising Turbine, 6.0; Intermediate Pressure Cruising Turbine, 6.0

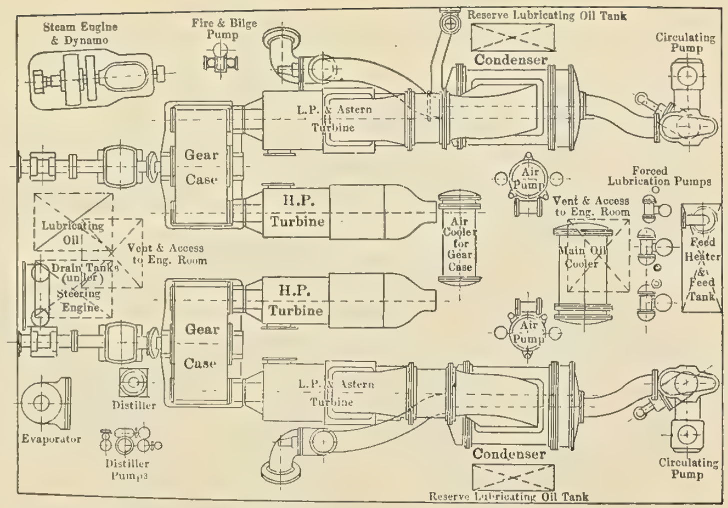


Fig. 7.—Arrangement in Engine Room, P. C. Vessels. Total Shaft Horsepower, 3,500; Revolutions of Turbines, 3,500; Revolutions of Propeller Shafts, 300

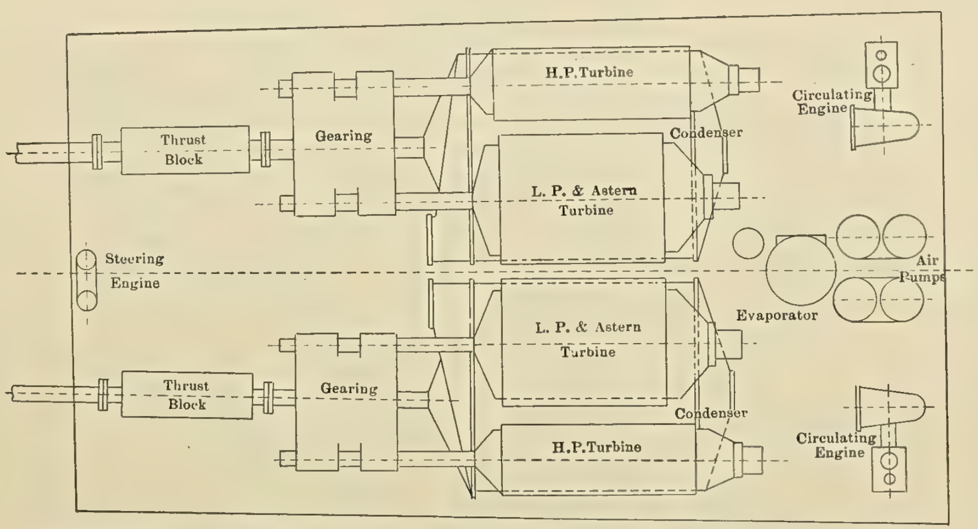


Fig. 6.—Plan of Machinery Installation, Torpedo Boat Destroyers *Leonidas* and *Lucifer*. Total Shaft Horsepower, 22,600; Revolutions of High Pressure Turbines, 3,350; Revolutions of Low Pressure Turbines, 1,800; Revolutions of Propellers, 380

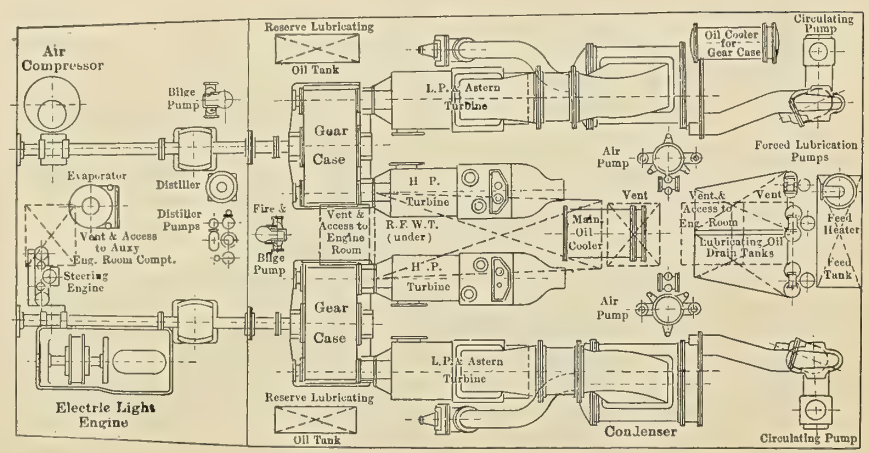


Fig. 8.—Arrangement in Engine Room, P. Vessels. Total Shaft Horsepower, 3,500; Revolutions of Turbines, 3,500; Revolutions of Propeller Shafts, 300

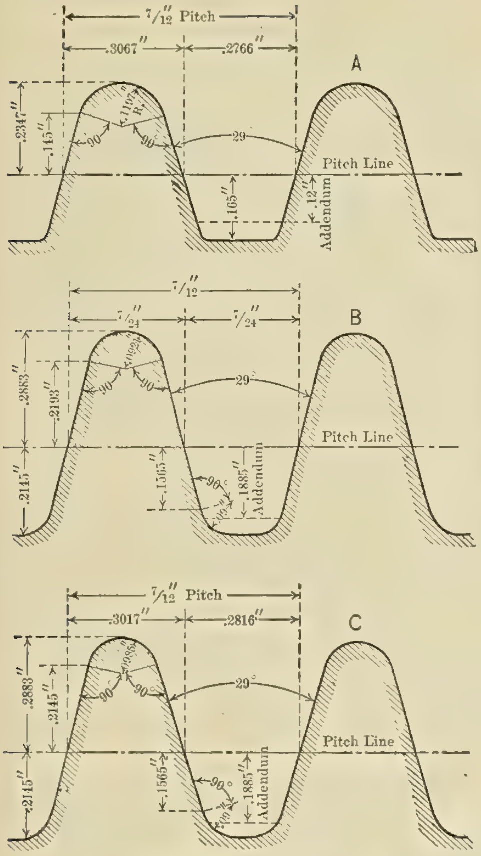


Fig. 9.—Typical Hobs

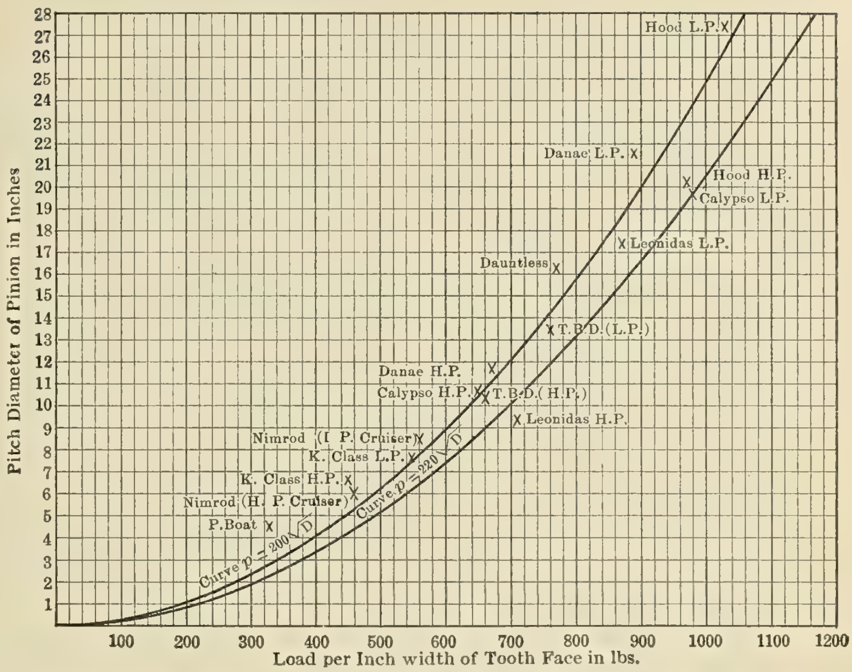


Fig. 10.—Diagram Illustrating Relation Between P. C. D. of Pinion and Tooth Pressure Per Inch Width for Typical Cases Compared With Curves $p=200\sqrt{D}$ and $p=220\sqrt{D}$

oil under a pressure of from 5 to 10 pounds, the jet being fan-shaped, so that the whole length of the teeth is lubricated. In early practice nozzles were fitted to discharge to the line of contact both on the entering side when running ahead and also when running astern, but the latter groups are not now fitted, as experience shows they are not required, considering the short periods of astern working usual in naval vessels.

Figs. 11 and 12 show a type of sprayer fitted, together with its arrangement on the gear case.

The teeth of gearing engage by line contact, but it must be appreciated that contact under a load can no more occur on a line than the load on a ball bearing can occur on a number of geometrical points. Elastic deformation of the surfaces must take place under the load, and the momentary flattening leads in each case to a surface contact. Owing to the lubrication, however, the load that can be safely sustained between two sliding surfaces in contact is decided by the pressure in the oil film between them and by the area of the film. Modern developments in the theory of lubrication seem to show that the pressure in an oil film between two surfaces varies as the thickness of the film, and that beyond a certain thickness of film no pressure is maintained. For a given thickness of film it will extend over an area practically proportional to the square root of the radius of curvature of the surface, and this area may be regarded as the virtual area of tooth contact. The radius of curvature may be taken on the pinion teeth alone, as the gear wheel teeth are sensibly flat, and as this average radius

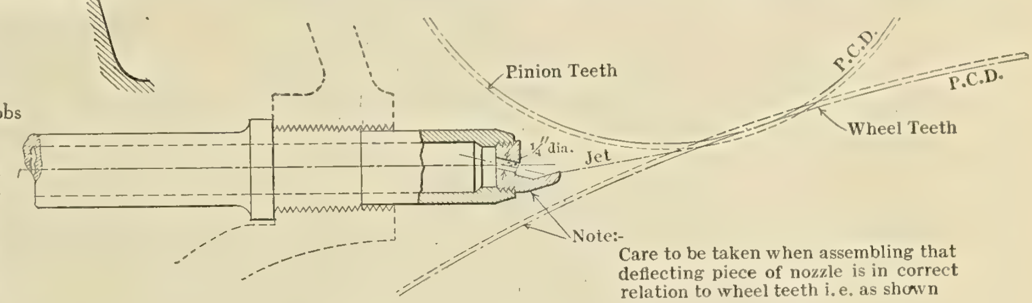


Fig. 11.—Sprayer for Lubricating Gearing Teeth

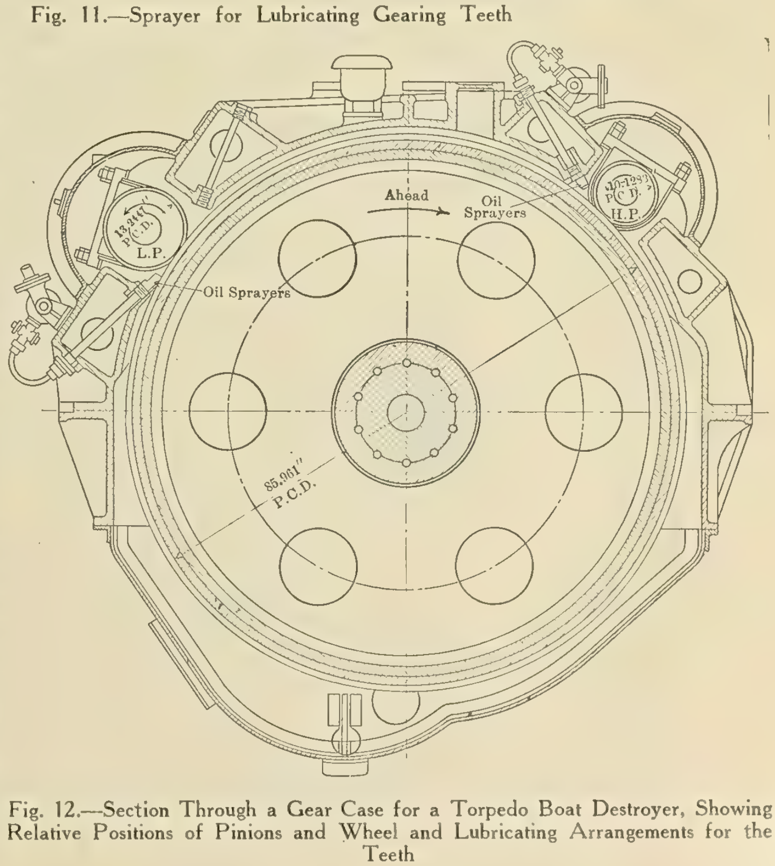


Fig. 12.—Section Through a Gear Case for a Torpedo Boat Destroyer, Showing Relative Positions of Pinions and Wheel and Lubricating Arrangements for the Teeth

TABLE 1.—SHOWING PARTICULARS OF GEARING IN TYPICAL VESSELS

		Battle Cruiser	Light Cruisers			Torpedo-boat Destroyers				"K" Boat	"P" Boat	Flotilla Leader (Geared Cruisers)	
		Hood	*Danæ*	*Dauntless*	*Calypso*	*Seafire*	*Romola*	*Trinidad*	*Leonidas*			*Nimrod* *H.P.C.*	*I.P.C.*
Horsepower	H.P.	17,500	8,600	10,000	8,000	6,250	6,250	6,250	5,150	2,250	875	1,250	3,580
	L.P.	18,500	11,400	10,000	12,000	7,250	7,250	7,250	6,100	2,750	875	—	—
Revolutions per minute	H.P.	1,497	2,568	1,800	2,662	2,985	2,970	3,000	3,340	3,300	3,500	2,380	2,850
	L.P.	1,098	1,403	1,800	1,435	2,262	2,270	2,290	1,815	3,000	3,500	—	—
	Propeller shaft	210	275	275	340	350	350	350	380	380	300	342	483
Pitch circle diameter in inches	H.P. pinion	20.174	11.755	15.319	10.728	10.0694	10.1283	10.101	9.603	6.7526	4.60	6.018	8.111
	L.P. pinion	27.51	21.514	15.319	19.886	13.2830	13.2447	13.2176	17.648	7.5316	4.60	—	—
	Gearwheel	143.787	109.789	99.897	83.991	85.9114	85.961	85.988	84.348	58.9552	53.862	41.864	48.405
Addendum of teeth, inches		0.266	0.1855	0.1855	0.12	0.12	0.12	0.284 Pinion 0.048 Wheel	0.1855	0.12	0.168	0.1855	0.1855
Number of teeth	H.P. pinion	55	53	71	41	47	39	39	37	26	24	23	31
	L.P. pinion	75	97	71	76	62	51	51	68	29	24	—	—
	Gear wheel	392	495	463	321	401	331	332	325	227	281	160	185
Pitch, in inches	Normal	0.99847	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.5196	0.583	0.583
	Circular	1.153319	0.69679	0.67783	0.8220	0.6730	0.815875	0.8156	0.8153	0.8158	0.600	0.822	0.822
	Axial	2.002	1.06	1.4285	0.8275	1.16	0.835	0.836	0.834	0.835	1.04	0.822	0.822
Helical angle		29° 57′	33° 12.4′	30° 40.3′	44° 49.8′	29° 58.9′	44° 23.6′	44° 25′	44° 22′	44° 23.6′	30°	44° 49.8′	44° 49.8′
Tooth angle	Normal	14° 28.7′	14° 29.5′	14° 29.5′	14° 29.5′	14° 29.5′	14° 29.5′	14° 29.5′	14° 29.7′	14° 29.5′	17° 30′	14° 29.5′	14° 29.5′
	Circular	16° 36′	17° 12′	16° 44′	20° 2.5′	16° 37.5′	19° 57′	19° 55′	19° 56′	19° 57′	20°	20° 6′	20° 6′
Width of pinion face, in inches	Total	75	53	60	54	40	40	40	29	28	21	24	35
	Effective	73.25	51.25	58.25	52.6	38.25	39.5	38.6	27.6	26.9	20.5	24	35
Number of teeth engaging		36.60	48.3	51.7	63.5	33.0	46.7	46.2	33.1	32.2	19.71	29.2	42.6
Length of tooth contact, in inches, per tooth	H.P.	3.525	2.125	2.38	0.94	1.58	0.97	1.21	1.46	0.9625	1.79	1.337	1.39
	L.P.	3.63	2.185	2.38	0.94	1.58	0.97	1.21	1.51	0.9625	1.79	—	—
Total length of contract, in inches	H.P.	128.8	103.3	123.0	59.7	52.2	45.3	55.9	48.4	31.0	35.30	39.08	59.2
	L.P.	132.9	105.5	123.0	61.3	52.2	45.3	55.9	49.9	31.0	35.30	—	—
Tangential load, in pounds	H.P.	73,000	35,850	45,700	35,200	26,200	26,200	26,200	20,300	12,700	6,840	11,000	19,500
	L.P.	77,200	47,500	45,700	53,000	30,500	30,500	30,500	24,040	15,400	6,840	—	—
Normal load, in pounds	H.P.	87,000	44,400	55,000	51,500	31,300	38,000	38,100	29,350	18,400	8,300	16,150	28,600
	L.P.	92,600	58,700	55,000	77,500	36,300	44,000	44,100	34,800	22,300	8,300	—	—
Load in pounds per inch, tooth length of contract	H.P.	675	430	449	871	600	838	681	606	594	234	413	483
	L.P.	697	556	449	1,260	695	970	790	697	720	234	—	—
Load, per inch, on total width of tooth face in pounds (=P)	H.P.	965	677.5	762	650	655	655	655	701	453	325	458	557
	L.P.	1,030	896.0	762	980	760	760	760	830	550	325	—	—
K in formula $P = K\sqrt{P.C.D.}$	H.P.	215	197.5	195	198	206	207	206	226	174	152	187	196
	L.P.	196	193.0	195	220	208	207	208	198	200	152	—	—
Speed of teeth at pitch line in feet per second		132	132	120.4	124.8	131	131	131	140	97.6	70.0	62.5	101
Maximum rubbing velocity of teeth in feet per second	H.P.	11.5	14.6	10.5	8.5	11.5	8.9	18.9	9.5	11.0	15.5	12.1	14.5
	L.P.	9.5	8.3	10.5	4.9	7.2	6.2	14.4	16.9	11.0	15.5	—	—
Stress at root, in pounds per square inch	H.P.	3,040	3,530	3,540	5,850	4,150	5,680	—	4,980	4,000	1,900	3,900	4,740
	L.P.	3,140	4,580	3,540	8,500	4,820	6,680	—	5,720	4,850	1,900	—	—

of curvature of the tooth form varies as the pitch diameter of the pinion, an empirical rule depending to a certain extent on the helical angle for the allowable tooth pressure $p = K\sqrt{D}$, where K is constant, is obtained, p being the intensity of pressure in pounds per inch of axial length. The values of K for a large number of cases are shown in Table I and are seen to be round about 200-225 in the majority of cases. The pressures obtained per inch width of face are also shown, and vary from 700 to 1,030 in the high powered installations at the nominal full power. Table I and Fig. 10 illustrate these points in typical cases.

(*To be concluded.*)

New Docking Facilities at San Francisco Plant of Bethlehem Shipbuilding Corporation

THE Union plant of the Bethlehem Shipbuilding Corporation, Limited, or the "Union Iron Works," as it has been known for thirty-five years or more, has always enjoyed the highest reputation for economy, efficiency and speed on all types of ship repairs and construction work. This has been due to its superior waterfront facilities, its modern equipment and efficient personnel. With the completion of the waterfront improvements now under construction and the recent acquisition of the new 12,000-ton floating dry dock, the facilities and equipment of this plant easily surpass those of any other shipyard on the Pacific Coast and are unsurpassed by few yards in the world.

12,000-Ton Floating Dry Dock

The new 12,000-ton floating dry dock was purchased from the Ames Shipbuilding Company, of Seattle, just prior to its completion by that company. It is now being towed down to the Union plant on San Francisco Bay and is expected to be in full operation by September 1. The dock consists of four sections of 3,000 tons capacity each; each section being 90 feet long and 126 feet wide, both end sections having an apron of 27 feet, the interval between the sections being 2 feet 6 inches or a total length over aprons of 421 feet 6 inches. It has a depth of 27 feet over the keel blocks, and with the exception of a few battleships now on the Pacific Coast it is able to handle all ships that normally come into the harbor of San Francisco.

Location of the Dry Docks

In order to concentrate its floating dry docks, the No. 3 dock will be moved to the Potrero Works from the Alameda Works; this will give the Potrero Works the following floating dry docks:

No. 2.—270 feet 0 inches long, 66 feet inside width, 2,000 tons capacity.
No. 3.—301 feet 0 inches long, 68 feet inside width, 2,500 tons capacity.
No. 4.—450 feet 0 inches long, 80 feet inside width, 6,500 tons capacity.
No. 5.—420 feet 11 inches long, 90 feet inside width, 12,000 tons capacity.

(All of these docks are operated by electricity.)

The Alameda plant will have:

No. 1.—Marine railway, 320 feet 0 inches long, 70 feet wide with 4,000 tons capacity.
No. 2.—Marine Railway, 220 feet 0 inches long, 60 feet wide, with 2,000 tons capacity.

(The marine railways are operated by steam.)

Hunter's Point will have:

No. 2.—Graving dock, 750 feet long, 103 feet wide at the top and 86 feet wide at the bottom.
No. 3.—Graving dock, 1,020 feet long, 153 feet wide at the top and 110 feet wide at the bottom.

(The equipment for No. 2 graving dock is opearted by steam, and that for No. 3 dock by electricity.)

The graving docks are cut out of solid rock and lined with concrete.

No. 3 graving dock is one of the largest in the world. It will handle with ease the largest ship afloat, either merchant or naval. It is so designed that it will receive any ship that is capable of passing through the Panama Canal.

It is just as essential to have sufficient lineal mooring capacity as it is to have a large number of dry docks and marine railways. The Union plant is not lagging behind in this most essential requisite. The relation between wharfage and dry dockage has always been maintained and is now being increased due to the purchase and addition of the new docks.

New Wharves and Extensions

Wharf No. 5 is being extended 320 feet and a new wharf is being constructed 587 feet long and 60 feet wide, parallel to and 200 feet distant from wharf No. 5. This wharf is an extension to the present system and connects with the other wharves and the plant proper by a wharf 50 feet wide.

This new wharfage construction will provide an additional 60,000 square feet of wharfage, all of which has been designed to carry a load of 500 pounds per square foot. The lineal mooring capacity will be increased by approximately 2,500 feet, giving six additional berths or a grand total of twenty-one.

At the Alameda plant the present bulkhead wharf will be extended 400 feet, making it 1,300 feet in length. A new fireproof electric sub-station is being constructed as well as a new paint shop, a building for the employment department and a hospital.

At Hunter's Point the wharf at the entrance to No. 2 graving dock will be entirely reconstructed.

New Piers Built of Creosoted Piling

It is noteworthy that these new piers are being built throughout of creosoted piling. To those unfamiliar with the devastation of marine life on the Pacific Coast, particularly the borings of the teredo, that statement may mean little; the fact is, however, that green piling has a life of about two years, whereas creosoted piling will endure indefinitely. With a creosote impregnation of twelve pounds to the square foot and penetration of one-half to three-fourths inch, the piling is immune to the attacks of the teredo, provided that the surface of the piling is not broken so as to expose impregnated wood. In brief, the Union plant aims at permanency in this new work.

The railway system will be extended so as to serve all the new wharves under construction. These wharves will be piped for air, steam, water, and a complete electric wire system of the most modern construction will be installed.

In addition to its dry docks and wharves, the Union plant's complete facilities are unsurpassed on the Pacific Coast. It has seventy modern fireproof buildings of 1,500,000 square feet of floor space all equipped with modern machinery, three shear legs, three work barges, tugs and launches, and the largest stock of material carried by any shipbuilding plant on the Pacific Coast.

Ship Repair Record of the Union Plant

Besides its wonderful record in the construction of merchant and naval vessels which is known throughout the world, it has repaired or dry docked not less than 2,500 vessels in the past thirty-two months, a record that speaks well for San Francisco Bay shop facilities and the Union plant.

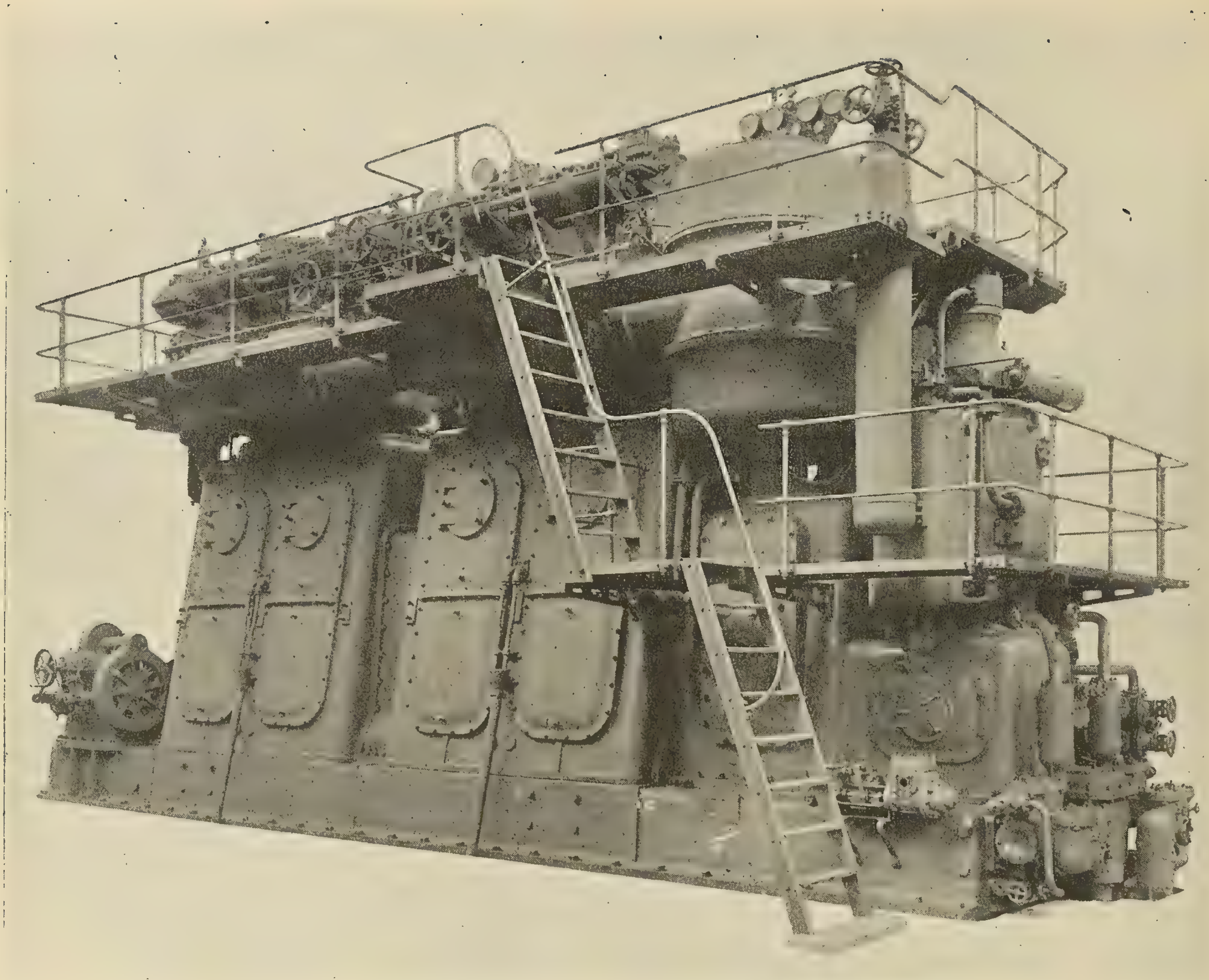


Fig. 1.—1,100 Brake Horsepower Marine Type Busch-Sulzer Diesel Engine

The Busch-Sulzer Diesel Engines

BY C. H. PEABODY, DR. ENG.

These engines are operated on the two stroke cycle, the scavenging and charging air being admitted through ports in the cylinder liner, so that only the fuel valve is required to be fitted in the cylinder head. Simplicity, reliability, reduction in size, weight and cost as compared with the four cycle type and the ability to burn low grade and impure oils are the advantages claimed for these engines.

THE first successful Diesel engine was completed by Dr. Rudolph Diesel in 1897, and his engine has in a quarter of a century been developed and stabilized in its various types and for many purposes. In 1898 the first American Diesel engine was built in Saint Louis by the company which is now known as the Busch-Sulzer Brothers Diesel Engine Company of that city. That company has partnership affiliation with the Sulzer Freres of Winterthur, Switzerland, and has the advantage of their experience in manufacture of many Diesel engines and of their experimental investigations of engines of various types, including an engine which develops 2,000 brake horsepower in a single cylinder.

The American company, from their own experience and with the information received from Switzerland, is giving special attention to the two stroke type of Diesel engine, both for marine and stationary purposes, though they build four stroke engines and recommend them for certain purposes.

At the time when Diesel proposed his engine the engineering, metallurgical and industrial conditions enabled him to proceed directly and rapidly to its development. There were problems enough in consequence of the high pressures and temperatures experienced in the cylinder of his engine; these problems even now are not completely solved for large engines, even though the engineering geniuses of many countries have wrestled with them for a quarter of a century. Dr. Diesel was very optimistic concerning the ultimate development of his engine, and in conversation with the writer expressed a positive opinion that the problems remaining were engineering problems rather than thermal problems; the writer ventures the opinion that the thermal problems, not yet completely solved, are the more obstinate.

Two Versus Four Cycle Engines

The opinion just stated gives intense interest to the matter of types; whether the Diesel engine shall be two stroke or four stroke. The two stroke engine, which has its own difficulties, has the great advantage of using one working stroke for each revolution of the crank. Could it take full advantage of this circumstance, the engine could develop twice the horsepower per cylinder possible with the four stroke type. Though the two stroke engine may come short of realizing such a gain, it has a great interest for marine engineers who appreciate the advantages of saving weight and space on shipboard.

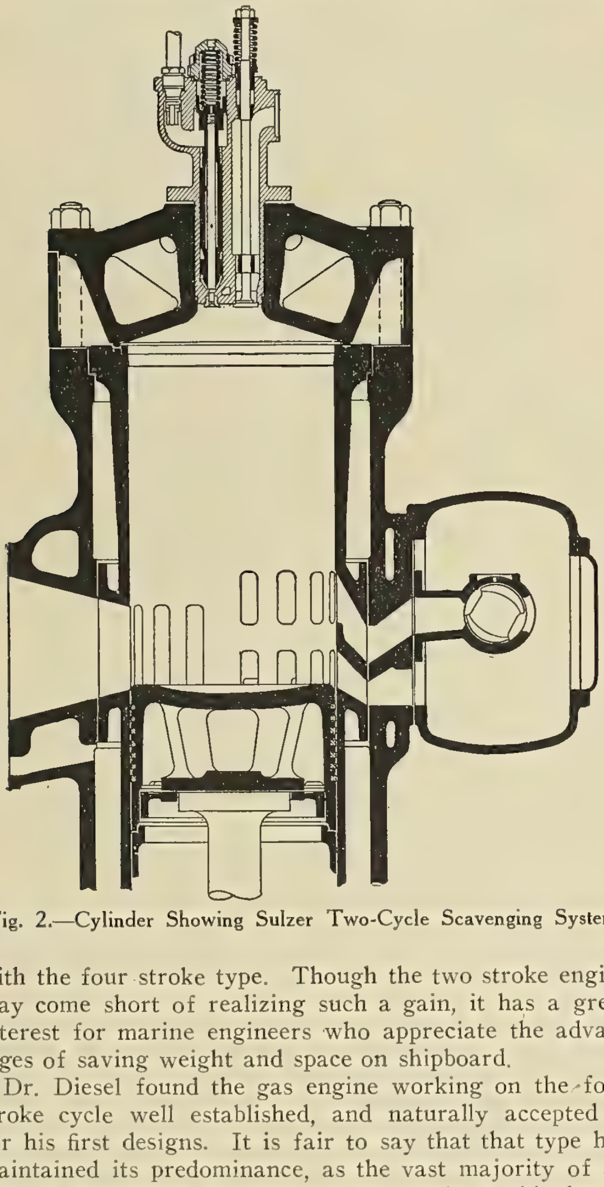


Fig. 2.—Cylinder Showing Sulzer Two-Cycle Scavenging System

Dr. Diesel found the gas engine working on the four stroke cycle well established, and naturally accepted it for his first designs. It is fair to say that that type has maintained its predominance, as the vast majority of all internal combustion engines are four stroke to this day.

Two Cycle Gas Engine

About 1880, Mr. Dugal Clerk undertook the production of a two stroke gas engine. In his book (now a classic) on the gas engine he admits that the problem became the more serious as he advanced. Mr. Clerk, a profound student and an experienced engineer, succeeded in making a two stroke engine which under laboratory test gave as good an efficiency as the four stroke engines of the same size then in use; in fact, he succeeded in showing a slight advantage when running the engine himself for laboratory tests. He could show reason why the two stroke engines should be more efficient; all two stroke proponents to the present day can also show reason. The writer leans toward conviction when reading their arguments and can see no reason why the two stroke Diesel engine, as built by the Busch-Sulzer Brothers Diesel Engine Company, cannot show at least as good economy as a four stroke engine.

It is worth while considering Mr. Clerk's engine, because all two stroke engines use his methods and because the reason for his failure is evident. In the first place he exhausted his engines through ports in the cylinder which were uncovered near the end of the working stroke. In the second place he slightly compressed the new charge (to five or ten pounds) and used it to push on the spent gases. He compressed the new charge in a separate cylinder with crank and connecting rod, giving the crank a little angular advance. He carefully shaped the cylinder head so that the new charge might advance unbroken and sweep out the spent gases just before the piston closed the exhaust ports for the compression stroke. The problem was to sweep out the spent gases without wasting the new charge. Mr. Clerk must have come pretty near doing this in his own tests. In practice fresh gas was wasted and spent gas remained behind. The failure of the two stroke gas engine was due to the necessity of compressing the mixed charge of air and fuel. Some gas engineers may object to one dictum, for many small gas and gasoline engines are working on the two stroke cycle, and also many large gas engines that use blast furnace gas or other low grade fuel. The company whose engines are under discussion concede an advantage of six or eight percent in fuel economy to the four stroke Diesel engines over their two stroke engines under shop test. They claim that in practice the margin is smaller and that commercially the two stroke engine has the advantage because it can use cheaper and impure oils and because it calls for less overhaul and repair.

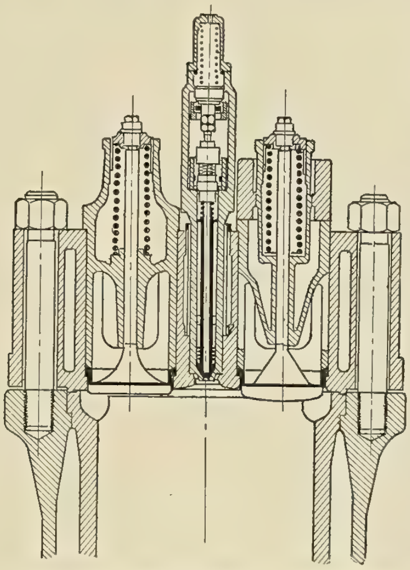


Fig. 3.—Cylinder Head of Four-Cycle Construction

Cylinder Head

The two features that give the Busch Sulzer Diesel two stroke engine advantage over others of the same type are (1) the simplicity of the cylinder head, and (2) the method of scavenging.

Fig. 2 enables us to understand both of these features. The cylinder head is a simple hollow casting which expands symmetrically with the rise of temperature and which is easily water-cooled. Contrast it with the cylinder head of a four stroke engine as shown by Fig. 3. Here are shown the supply and exhaust valves and also the fuel valve for a four stroke engine, but the starting valve (not in the same plane) is not shown. Now many two stroke engines have the scavenging valves in the cylinder head and are in much the same condition, especially if the scavenging valves are duplicated to avoid large size. We remember that the scavenging valves pass the air under low pressure of not more than five to ten pounds.

The Busch-Sulzer engine has only two valves in the cylinder head—the little fuel valve and a small starting valve, and the latter is closed in service. Both are in a single casting which can be easily removed for overhauling.

Scavenging System

As for the Sulzer scavenging system, we see in Fig. 2 that the exhaust ports are in the left side of the cylinder and are shown uncovered by the piston. They have a generous area, but, since the pressure of the gases at release is forty pounds, there is no trouble about the exit of the spent gases. The scavenging ports are in two tiers; the upper tier of ports receives air through a rotating valve, the lower open directly into the cylinder. This is

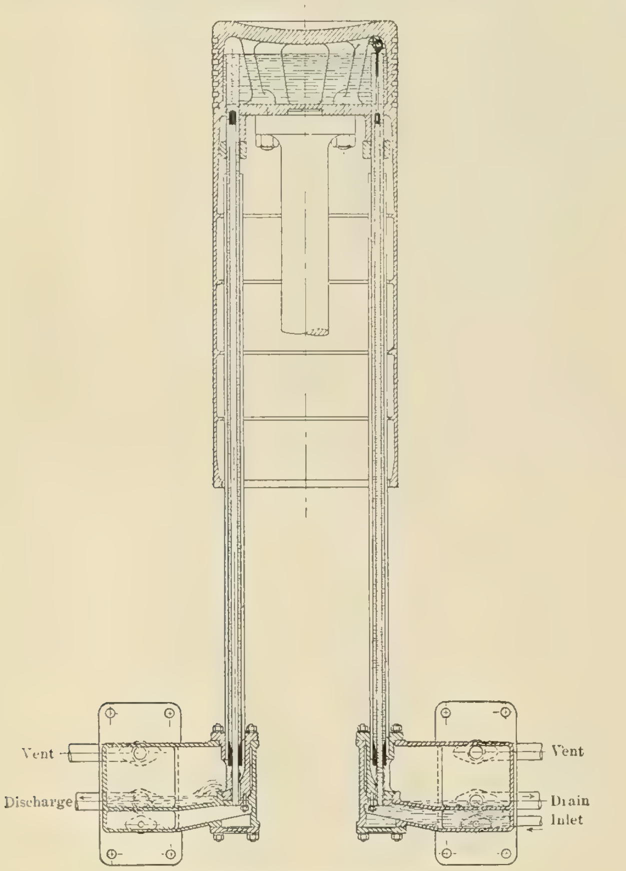


Fig. 4.—Busch-Sulzer Piston Cooling

what happens on the down stroke as the piston approaches release: (1) the piston opens the upper tier of scavenging ports, but nothing happens because the rotating valve is then shut and the scavenging air chest is protected against the release pressure of the gases; (2) the piston opens the exhaust ports on the left and they stay open till the piston closes them on the upstroke; (3) the piston, just before the end of the stroke, opens the lower tier of scavenging ports and fresh air blows across and out of the cylinder; (4) about this time the rotating valve opens and air blows up into the cylinder and cleans out the spent gases; (5) on the upstroke the piston closes the lower tier of scavenging ports, then the exhaust ports and finally the upper tier of scavenging ports, which latter supply a change of fresh, cool air for compression.

It is claimed that analysis shows only 3 percent of spent gas in the compression charge. Since the engine always and preferably works with air in excess, the only effect of a trace of spent gases is to slightly raise the temperature during compression, and again such a slight rise of temperature will merely reduce slightly the required pressure for ignition of the fuel. The question naturally occurs, why should the two stroke engine have to concede anything to the four stroke engine in economy?

The free exhaust through the ports in the side of the cylinder enables the two stroke engine to burn all kinds of low grade fuel, as there are no exhaust valves to be gummed up by asphaltum or destroyed by sulphur. This is a matter of double importance for marine engines, since ships must take such oil as they can get in remote quarters of the world.

Cylinder Cooling

A little internal combustion engine, especially if it works most of the time at reduced load, or even inter-

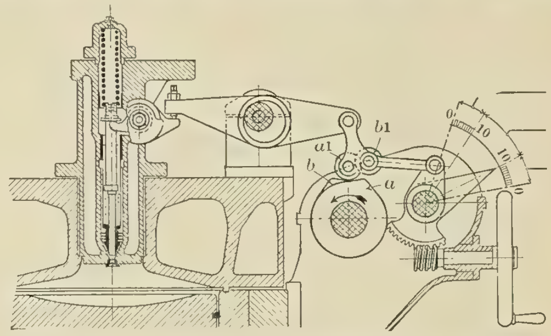


Fig. 5.—Diagram of Reversing Mechanism and Fuel Control

ruptedly, can get along almost any way; such are motorcycle engines. Some light automobiles are air cooled, but powerful automobile engines are water cooled on the heads and barrels of the cylinder. Large engines must be thoroughly water cooled, pistons as well as cylinders; and, further, it is advisable, if not necessary, to use forced lubrication of the bearings and in some cases to cool the oil. The difficulty of cooling an internal combustion engine increases with the size in geometric ratio. As the thickness of the cylinder walls must increase with the diameter and the rate of flow of heat decrease with the cylinder volume, that is, with the cube of the diameter, the difficulty will increase in proportion with the fourth power, while the area of the surface increases only with the square. Consequently the difficulty of cooling increases with the square of the diameter of the cylinder; that is to say, it is four times as troublesome to cool a 200-horsepower engine as a 100-horsepower engine, for with constant piston speed and mean effective pressure the power increases with the square of the diameter. Another way of looking at the matter is that with the same efficiency of cooling the inside of the cylinder will be hotter for the larger engine. This comes from the fact that a greater difference of temperature is required to force the heat through thicker walls. We must not be surprised that there is a tendency to reduce piston speed and mean effective pressure for large engines.

Piston Cooling

Whether or not the reader accepts the reasoning just given, he will readily agree that the water cooling of an engine is most interesting. We have already seen that the cylinder head is symmetrical and easily cooled. A glance at Fig. 2 will show that the cylinder barrel and liner can be cooled effectively and that the piston proper resembles the cylinder head in being symmetrical and well arranged for cooling; Fig. 4 will show how the water is supplied to the piston. It may be seen in the last figure that the water is supplied at the right to a long stationary pipe that reaches up into the piston and squirts water into it under pressure; the piston is shown only partially filled. Telescopic pipes allow the water to flow away without entering the crank case. Stuffing boxes and swinging joints are avoided.

The Piston

The piston proper is only long enough to carry the packing rings. Below it is an extension or skirt that covers the exhaust and scavenging ports when the piston is raised. This extension is thin and does not need to be water cooled. The piston is flanged onto the piston rod and the latter is forked at the lower end to take the connecting rod. The use of a crosshead will meet with the approval of all engineers and especially marine engineers. The connecting rod is of the marine type, adjustments of bearings being made by shims. An advantage of the two stroke cycle is that there is always a downward pressure on the connecting rod because the pressure of the gas at the top of the stroke is always more than enough to take care of the inertia forces.

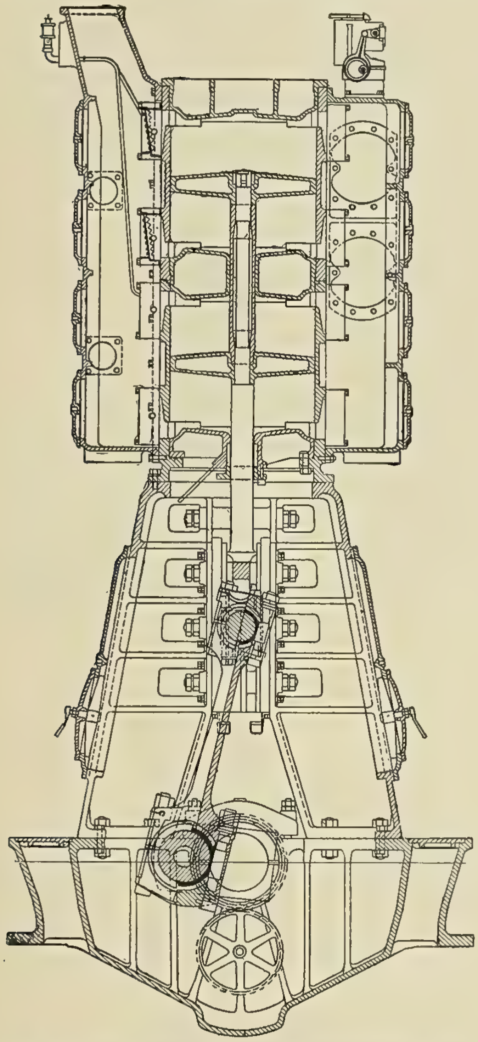


Fig. 6.—Cross Section Through Scavenging Pump, Busch-Sulzer Two-Cycle Diesel Engine

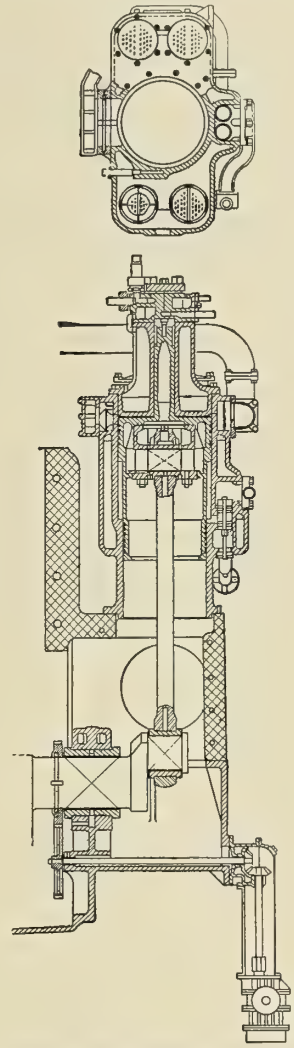


Fig. 8.—Cross Section Through Compressor

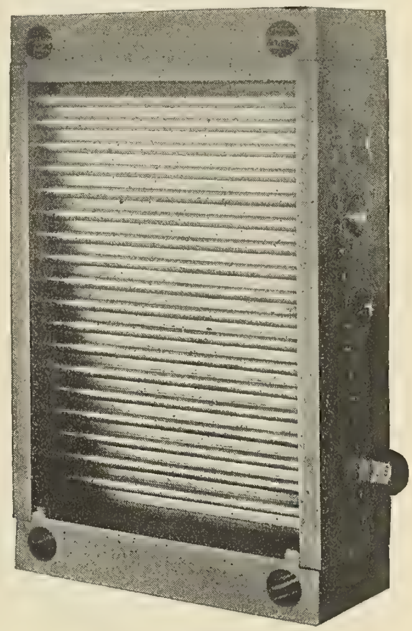


Fig. 7.—Shutter Valve

The Valve Gear

Since both exhaust and scavenging take place through ports in the cylinder walls, and since the starting valve is shut when the engine is running, the valve gear is simple and light because it handles only the fuel valve. The advantage of this arrangement is most evident in the arrangement of the reversing gear for the marine engine which is shown by Fig. 5, where *a* is the cam for forward motion acting on the roller *a*; the cam *b* for backing is by the side of cam *a*, out of gear as shown in the figure. To back the engine, the hand wheel is turned until the roller *a* is lifted out of action and the roller *b* is brought into gear. Of course, all of the gears can be changed for the several cylinders of the engine by extending the reverse shaft for that purpose.

The stationary engine is controlled by a governor which determines the seating point of the suction valve of the fuel pump, each cylinder having its own pump. There is also an emergency governor that cuts off the fuel supply if the engine starts to run away. Marine engines have a governor of the latter type to prevent racing.

Scavenging Pump and Air Compressor

The scavenging pump and the air compressor are usually driven directly from the main shaft. The crank for the scavenging pump is similar to those for the working cylinders. The air compressor is driven from a short overhung crank at the end of the shaft. The scavenger pump is shown by Fig. 6; it has two pistons tandem on the same rod, both being double acting. Having in mind that the scavenging pump handles a large volume of air at low pressure, the advantage will be recognized of using shutter valves as shown by Fig. 7.

In a submarine there is a turbo-blower for supplying the scavenging air. The blower is driven by an electric motor, the current coming from a separate generating set with its own engine. Such a drive for scavenging appears to be advisable on all ships, especially if electricity is used for driving auxiliaries, deck windlasses and winches. The air compressor has three stages with intercooler and an after cooler, as shown by Fig. 8. At the middle of the compressor is the low pressure piston actuated by crank and connecting rod. Below the piston is a trunk that works the second stage, and above is a plunger for the third stage, making a very compact arrangement.

All bearings and gears are lubricated by a forced circulation of cooled oil.

Various reasons why the two stroke Diesel engine has advantages for marine propulsion have been pointed out incidentally, such as reduction in size, weight and cost as compared with four stroke engines, and also the ability to burn low grade and impure oils, the latter offsetting to a large extent whatever advantage the four stroke engine may have in economy. There remains the great advantage of one working stroke for each revolution of each crank.

Advantages of Two-Cycle Engine

Steamship practice has settled on the three cylinder triple engine as the standard, and that engine is a particularly sweet engine to run and has long been a favorite with marine engineers. Four crank engines have been built for large steamers, but they are accepted rather than desired. And yet the two crank compound engine gives satisfactory service and a fairly smooth turning moment. The four cylinder two stroke engine is the equal of the two crank steam engine and is to be recommended for ships that can get power enough from one or two such engines. They will handle easily and run satisfactorily. Where more power is needed, the six cylinder engine may be preferred. For light high speed engines six cylinders will be advantageous if, indeed, they are not necessary. Such an engine, if its base is rigid enough, will be perfectly balanced for all inertia forces and moments. The cranks should be balanced individually by counterweights to avoid slight springing of the shaft. Such slight springing does not hurt the shaft, but it increases bearing friction and wears out the bearings.

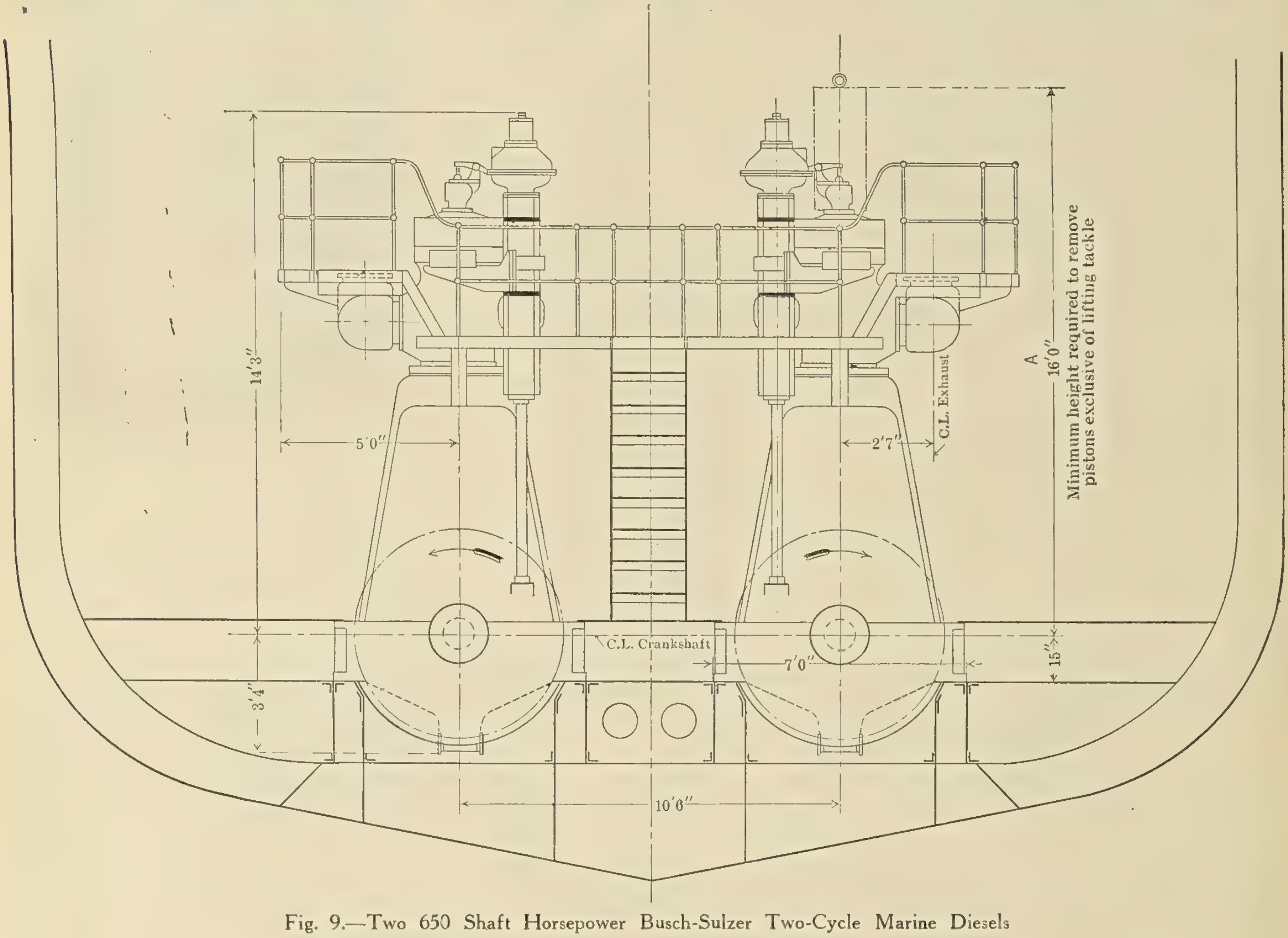


Fig. 9.—Two 650 Shaft Horsepower Busch-Sulzer Two-Cycle Marine Diesels

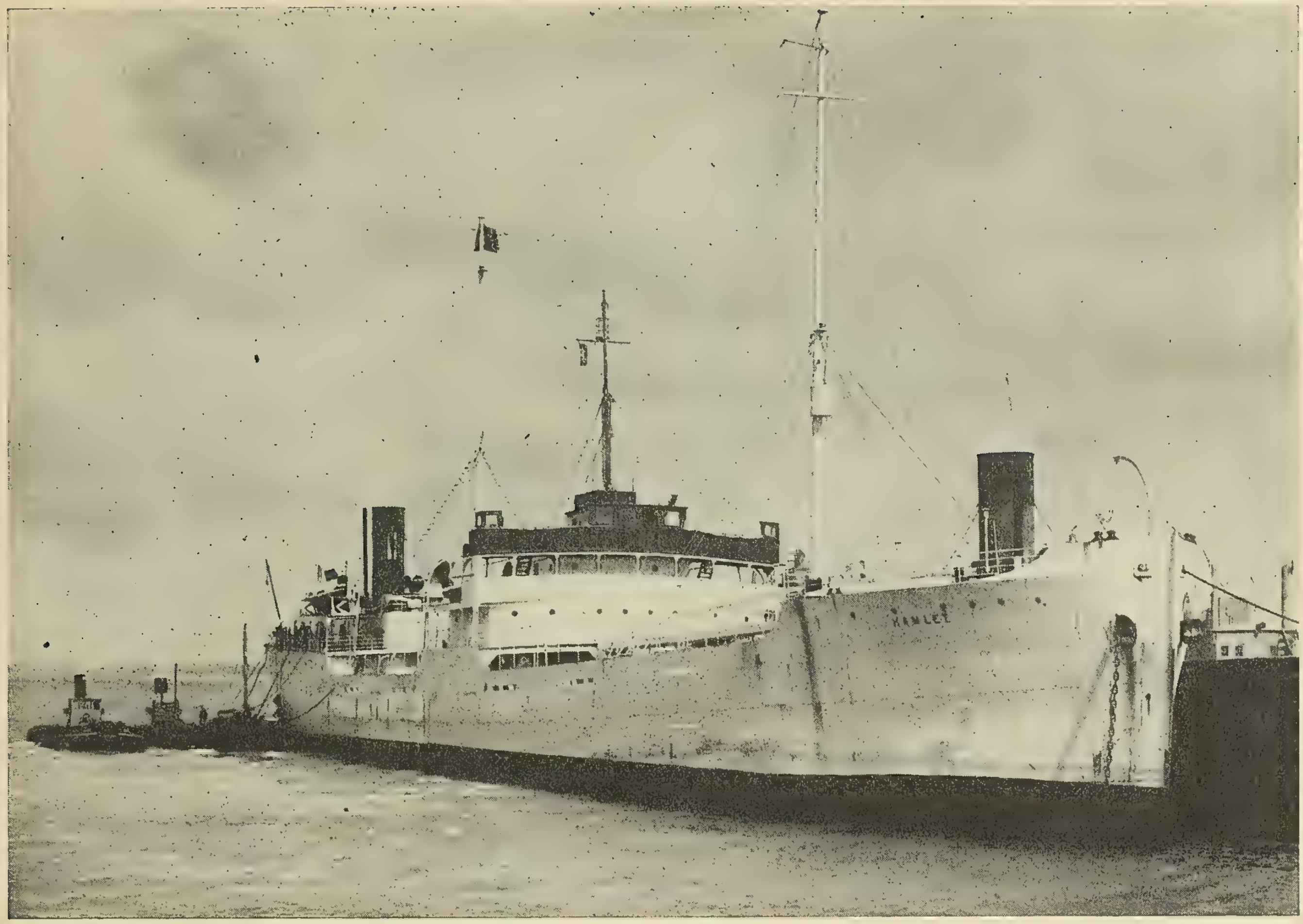
Comparison of Sizes and Weights

In the comparison of two and four stroke engines it is usual to point out that the former can be smaller, lighter and cheaper and let it go at that. Now there is a strong tendency to run all internal combustion engines, and especially to run Diesel engines faster than equivalent steam engines. The reason is that the entire propelling machinery (i. e., the engines themselves) is reduced in size and weight. A steamship has commonly more weight in the boilers than in the engines, and it is the latter only that gain advantage from running faster.

Propeller Efficiency

The consequence of the high speed of revolution of internal combustion engines is the necessity of using smaller propellers with less pitch ratio and higher percentage of slip. The loss of propeller efficiency from this source is likely to be 8 or 10 percent. It is therefore urged that engineers who use two stroke Diesel engines on shipboard, instead of trying only to save space and weight, consider the advantage of a slower speed of revolution and get a better propeller efficiency, thus offsetting the margin of better efficiency claimed for the four stroke engine.

Superheated Steam and Reciprocating Engines.—That the economy of coal when using superheated steam with reciprocating engines is considerable is indicated by some figures recently given regarding two twin screw vessels of nearly the same size, fitted with quadruple expansion engines and similar boilers, saturated steam being used on one vessel and superheated steam on the other. It was found, as a result of voyages extending over four years, that there was a saving of coal of seven to eight tons per day with the vessel using superheated steam, representing an economy of over 10 percent.—*Shipbuilding and Shipping Record.*



The Norwegian Motor Oil Tanker *Hamlet* Fitted With Two Polar Diesel Two-Cycle Engines

Motorships Being Standardized in Europe

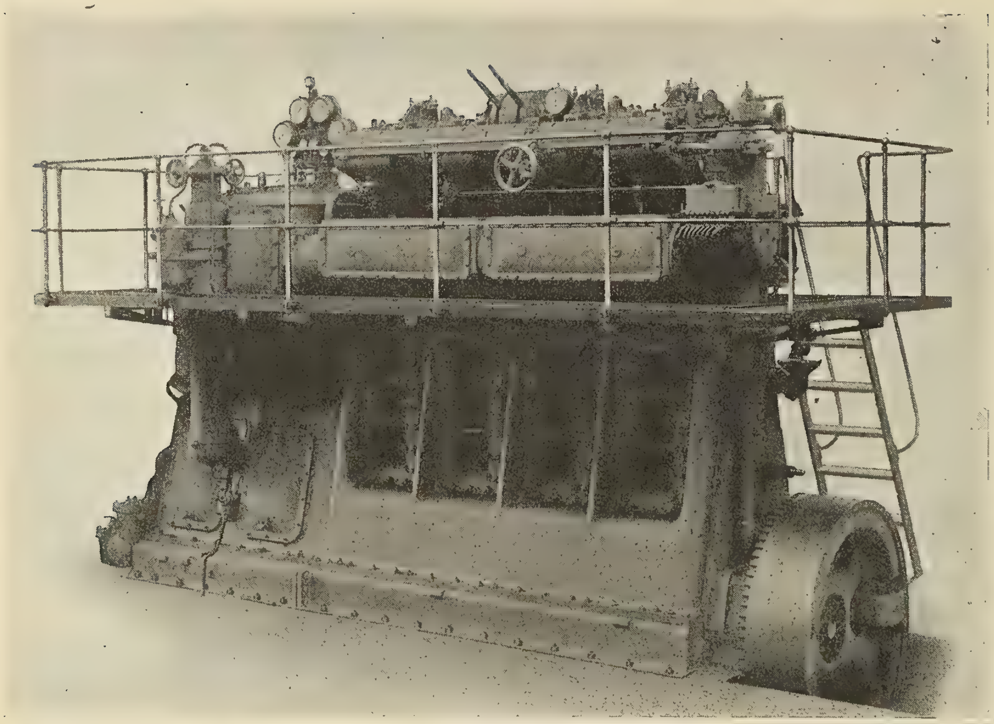
Vessels Nearing Completion in Denmark and Sweden of Standard Types—Duplicates Ordered—Germany Preparing to Develop Motorship Industry

BY OUR SPECIAL LONDON CORRESPONDENT

DURING the past month two large motorships have been put into commission, one built in Denmark and one in Sweden, while another 14,000 tonner has been launched in Great Britain. It is anticipated that within the course of the next few weeks not less than half a dozen large new vessels will be completed, including the first 14,000-ton Glen motor liner *Glenogle,* fitted with 6,400-horsepower machinery. This steady increase in the European motorship fleet shows that the progress of the marine internal combustion engine is being steadily maintained, one of the most interesting features being the development of the idea of the production of standard vessels. For instance, one of the new ships mentioned above, the *Elmaren,* built by the Gothenburg Shipbuilding Company at Gothenburg, is a sister vessel to two vessels, the *Bullaren* and *Tisnaren,* which have been in commission for about a year and eighteen months respectively, and have proved extremely economical and reliable craft. So successful have they been that the owners, the Transatlantic Company of Gothenburg, have now placed orders for six exactly similar vessels, all of them to trade between Scandinavia and Sweden to America.

The *Elmaren* carries 9,400 tons deadweight with a length of 436 feet, a beam of 56 feet and a depth of 30 feet, the draft being 26 feet 9 inches. These figures should be of interest to prospective builders and owners of motorships in America anxious to decide upon a standard craft of improved design. The Transatlantic Company has adopted the modern idea of giving their cargo boats relatively high speed, and they are all capable of maintaining twelve knots at sea. In order to attain this speed, two 2,000 indicated horsepower, six cylinder engines are installed with a cylinder diameter of 740 millimeters and a stroke of 1,100 millimeters. They are of the ordinary Burmeister and Wain design built under license by the Gothenburg firm and embody all the latest improvements which have been effected at Copenhagen.

On these engines a three stage air compressor is fitted, this being now commonly adopted for the Burmeister and Wain engines instead of the original arrangement of having only the high pressure stage directly coupled to the main motor. Water is now employed for cooling the pistons instead of oil, which was originally used, as it was found that this tended to carbonize within the piston and cause inefficient cooling. Some improvements have also been made in the exhaust valves, with the result that the



A 420-Horsepower Sulzer Marine Two-Cycle Diesel Engine

latest engines will operate for comparatively long periods without the necessity of changing these valves.

The Motorship Theodore Roosevelt

The second vessel just completed is the *Theodore Roosevelt,* constructed by Burmeister and Wain for Mr. Fred Olsen, of Christiania, the first of five similar vessels to trade between Scandinavia and the Pacific Coast of America through the Panama Canal. It is considered among Scandinavian shipowners that this route offers one of the best opportunities for the motorship—first, because it is a long trip and motor vessels show to special advantage on such routes, and, secondly, because oil can be obtained relatively cheaply on the Pacific Coast. The writer uses the word "relatively" advisedly, since liquid fuel in Europe is now costing anything up to £13 or £14 per ton, so that even the high price at Pacific Coast ports seems to European owners relatively cheap. It must, however, be remembered that coal in Europe costs from £5 per ton in London to about £12 per ton at Gothenburg, so that the motorship still shows an enormous advantage.

The *Theodore Roosevelt* carries approximately the same amount of cargo as the *Elmaren,* but is a slower boat, being equipped with two 1,550 indicated horsepower engines of the Burmeister and Wain type, instead of 2,000 horsepower as in the *Elmaren.* These give a speed of approximately 11 knots at sea, while the ship has a fuel consumption of only about 10 or 11 tons per day including all the auxiliary machinery. Needless to say, this is electrically driven, as practically every new motor vessel now built in Europe is equipped with electrical auxiliary plant.

14,000-Ton, 14-Knot Motorships

The 14,000-ton vessel just launched on the Clyde for the Glen Line is the second of its class and the first will start on her maiden voyage in the course of a few weeks. These ships, of which two more are to be built, are exciting exceptional interest, not only owing to their size, but also to their speed, which is between 13½ and 14 knots—an unheard-of figure for the average cargo vessel. It is, however, but another indication of the European shipowner's impression that higher speed is needed for cargo craft, and the motorship offers particular opportunities in this direction, since it can be run at three-quarter speed with comparatively little loss of efficiency.

The 14,000-ton ships are provided with a couple of 3,200 indicated horsepower engines, the speed on trials being over 14 knots when loaded. They carry about 20 passengers, and no effort has been spared to render them most efficient in the matter of handling cargo, the electric winches being especially powerful and numerous. This has involved the installation of three 400-horsepower Diesel driven electric generating sets, so that the total power of oil engines installed in the vessels is somewhere in the neighborhood of 7,600 horsepower.

The main engines are of the eight cylinder type with cylinders 740 millimeters by 1,150 millimeters and operate at 115 revolutions per minute. Both engines are fitted with two high pressure air compressors of the three stage type, each being sufficient to maintain the necessary supply of air in the event of failure of one. This precaution has been adopted owing to the fact that the greatest trouble experienced with Diesel engines during the past few years has been in connection with air compressors. It seems a matter of some difficulty to design a completely effective type, and troubles with valves have been fairly numerous.

Germany and Motorships

It is reported that shipowners and shipbuilders in Germany are making preparations to develop motorship building as soon as conditions become propitious, and it is stated that a combination of the A. E. G. and the Hamburg-American Line, which was suggested during the war, will shortly come into operation and a big shipyard and works at Hamburg will be devoted entirely to the construction of standard motor vessels. The engines will be of the opposed piston two cycle type, such as the A. E. G. was building before the war for stationary purposes on a large scale, although the majority of motors constructed were of low power. It is believed that a series of 8,000 ton craft fitted with 2,000-horsepower machinery will be built, and although a good deal of secrecy is maintained over this venture, there is little doubt that it will be carried out in the near future. In the meantime, two orders have been placed with Blohm and Voss for motorships for German shipowners, while the conversion of an existing steamer to motor power is now being made in Hamburg.

How an Engineer Got Rich

We have just learned of an engineer who started poor twenty years ago and has retired with the comfortable fortune of $50,000. This money was acquired through industry, economy, conscientious efforts to give full value, indomitable perseverence and the death of an uncle who left the engineer $49,999.50.—*Official Bulletin, Colorado Society of Engineers.*

Cargo Motorships vs. Steamships

Comparative Calculations of the Expenses and Earnings for the Operation of Steam and Motor Ships

BY CHARLES E. LUCKE*

CARGO motorships in overseas service have been steadily increasing in numbers for several years, and at an increasing rate, and this fact alone is proof of successful competition with steamers. The performance of these freighters has established beyond question the very superior fuel economy of the internal combustion over the steam type of propelling machinery, without any loss whatever in reliability when the oil engines are of good modern design. For all ocean freight service motorships must now be considered in commercial competition with steamships on quite the same terms as one type of steam freighter with another. The competition for a given size and speed of ship is reduced to a comparison of freight earnings, typical of one class of propelling machinery with reference to another. Earnings are measured by cargo capacity and freight rates on the one hand and on the other by operating costs per trip or per mile.

1. Method of Treatment

Comparing cargo capacities of two vessels of equal size and speed, but with different machinery, a difference in capacity is found for steam vessels, as in the case of steam turbines compared with reciprocating engines. The geared turbine invariably permits of greater cargo capacity both for deadweight cargo and measurement cargo (more or less than forty cubic feet per ton), but the amount of the difference naturally depends on the design of the reciprocating engines, the turbines, the boilers and the auxiliary machinery. The situation is quite the same in nature when the cargo capacity of motorships as a class is compared with that of steamships as a class, and while in this case the motorship usually permits of greater cargo capacity than steamships, the amount of the difference depends on the design of the machinery being compared.

Comparative Cargo Capacities

General figures of comparative cargo capacities of motorships as a class, with reference to steamships as a class, are useful for preliminary estimates but are not at all satisfactory or conclusive in a final analysis of the probable earnings of a given ship over a selected trade route. Commercial conclusions can be based only on careful calculations with actual or estimated values for each of the items entering into the total. This requires an analysis of the total deadweight† of the ship and the evaluation of all of the items, except cargo. The cargo weight is determined by subtracting the sum of these items from the total deadweight capacity of the ship. These deadweight items include the weights of (a) machinery; (b) fuel in bunkers; (c) water; (d) crew and effects; (e) stores, including food and spare gear. For comparative estimates it is sufficient to evaluate only those items that differ by a constant weight, as, for example, machinery weights for motorship over steamship, and minor items such as crew and effects may be ignored entirely, because difference between them in comparing two ships is of no consequence.

Fuel Capacity

To evaluate the weight of fuel to be carried in bunkers requires a definite assumption of the length of voyage, and a decision as to where and when refueling is to be done, in addition to fixing the fuel consumption per day at sea and in port. It is clear that a ship carrying fuel for a round trip on a long voyage will have less cargo capacity outbound than returning, and the difference will be equalized only if bunkers are filled at each end. The most complicated case is that in which the ship makes a stop at many ports and fills bunkers at all, or at a few of them. These are matters of ship operating management rather than type of machinery, but with the widely differing fuel consumptions per day for motorship vs. steamship, the question of relative suitability of one or the other for a given trade route at once arises, and the route factor may become the deciding one. In general, a long route with fuel in bunkers for the round trip is the condition most favorable to the motorship as a cargo carrier.

Operating Expenses

Comparative figures on ship operating expenses per day, per voyage or per year for two or more ships differing only in their machinery are not only quite as necessary as the comparison of their cargo capacities, for a conclusion as to the commercial merits of one over the other, but much more important. When motorships are compared with steamships on this expense basis, much greater differences are found than in the matter of cargo capacity, and these expense differences are always very much in favor of the motorship if fixed or investment charges are ignored. They are also in favor of the motorship even when including the fixed charges if the vessel is worked hard enough, that is, kept at sea instead of being held in port.

Fixed Charges

Fixed or investment charges are annual constant expenses and their value per mile or per voyage naturally is less as the miles per voyage or per year made by the vessel is greater. Motorship machinery always costs more than steamship machinery per horsepower, therefore investment charges against operation are always against the motorship. The importance of this item in the list of expenses becomes less as the operating expenses for labor and consumable supplies become larger, and the more the ship is worked the more the cost of consumed supplies, including fuel, controls the total. This operating expense is always in favor of the motorship, mainly because of its very low fuel consumption, so it is clear that whether the total cost of operating the ship (made up of fixed charges and operating expenses) will always favor the motorship or not will depend on the relative size of the two items—one always in favor and the other always against the motorship, the former and favorable item being larger and the latter unfavorable item smaller, as the ship is kept at sea the more days per year. To reach a decision on these

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† The term deadweight as used herein includes the machinery. Strictly speaking, the deadweight only covers portable objects as cargo, fuel, water, stores, crew and passengers.

costs, it is necessary to prepare an itemized statement and calculate or estimate the value of each item, including: (a) interest on investment; (b) depreciation, including obsolescence; (c) insurance; (d) maintenance; (e) loss and damage; (f) fuel; (g) water; (h) crew wage and subsistence; (i) stores; (j) port charges; (k) cargo handling.

Fluctuating Values

Values of these items can be determined only on the basis of assumptions of certain prices, which, like all market prices, are subject to wide fluctuation in any one place from time to time and considerable differences in different parts of the world. A leading example of this condition is fuel price, concerning which the only thing that seems to be sure is a general upward trend everywhere, judging from past figures. Crew wages and food costs entering into subsistence are likewise unstable, but not so widely as fuel prices. Consideration of such items must, therefore, involve a good deal of opinion and judgment, and appreciable differences in conclusions may well follow the use of maximum prices or wages in one calculation and minimum figures in another. However this may be, it is a fact that the quantities of these items to which the prices apply always favor the motorship. It necessarily follows, therefore, that *high prices of items of running expense make total operating costs more favorable to the motorship,* a very significant conclusion in view of present price tendencies.

Determination of Fixed Charges

Evaluation of fixed charges, or items of investment expenses, are even more dependent on opinion than prices of supplies or wages of labor, because these are largely fixed by the system of accounting used. Accountants differ widely in their practices as to interest charges on capital investment reduced to equivalent per ton mile, and still wider differences are to be found in the treatment of depreciation, obsolescence and maintenance, both in finding the value of each and in the relation of depreciation to maintenance on the one hand and of obsolescence in relation to period of interest charges or to depreciation on the other. As a consequence, all estimates of total expenses of operating one ship as compared with another must necessarily involve some more or less considerable variation when made up by different estimators, due to opinions on accounting; to estimates as to proper prices of supplies and wages; to voyages to be made; to days at sea or in port per year; to refueling points, and to relative amounts of cargo of the deadweight as compared with the measurement classes; and such items, all in addition to the determinable items of an engineering nature, such as fuel consumption per hour per horsepower. These sources of variation will account for the many differences of opinion as to the relative value of one type of ship compared with another for a given service, which have always existed and always will.

In spite of all these variables, some of fact and others of opinion, entering into the estimate of the cost of operating a ship per year, or the cost of carrying freight per ton mile, the fact remains that the only estimate worth while must be based on the evaluation of individual items. It is also true that for all reasonable values of these items in comparing motorships with steamships as cargo carriers the motorship will be found to be the most economical vessel operated on a trade route that is long enough.

To assist those interested in working out such cost comparisons some convenient forms and tables have been developed and for each item presents a brief discussion, with an estimate of a fair value for it for one size of ship. These should be useful to naval architects, marine engineers, shipbuilders, shipowners and shipping interests generally, not only for the values of the items and estimates of totals here presented, but also as a means of guiding individual new estimates when it is desired to determine the effect of a change in any one item, due to a new condition, or price, or service, or to a difference in opinion as to the proper value. The more common such cost calculations become, and the more accurately they are made, the quicker will the shipping world come to a correct understanding of the commercial value of motorships and their proper place in water-borne freight transportation. Without such calculations, the question will remain one of opinion unworthy of supporting a real business conclusion as to the value of motorships as investments.

2. Comparative Cargo Capacities of Motorship and Steamship of 10,000 Deadweight Tons

As cargo carrying capacity is to be calculated by differences between total deadweight and that of supplies carried for deadweight cargo, each of these items must be considered separately. A second calculation for measurement cargo (bales) measuring more than forty cubic feet per ton can then be made.

In this comparison the first item is weight of machinery, and after it weight of fuel for a given voyage, with other supplies and stores. This comparison is made in detail for two ships—one a steamer and the other a motorship of identical hulls and shaft horsepower. The basis of the estimates is the steamer, taken as 10,000 deadweight tons and propelled by a single screw with geared turbines and oil-fired Scotch boilers, and the usual steam auxiliaries for both engine room and deck service. This is quite generally accepted as the most economical cargo steamship. The motorship is propelled by twin screws, with two four cycle six cylinder Worthington reversible marine Diesel engines, direct coupled to the propeller shaft and having Worthington auxiliaries. These auxiliaries include Diesel electric generating sets in the engine room, generating electricity for ship lights and for operating electric motor driven pumps and compressors in the engine room, and steering gear, winches and windlass on deck.

Each ship is powered with 2,700 shaft horsepower, giving the ships each a speed of 11 knots or 264 nautical miles per day, assuming equal propeller efficiency for the twin screws of the motorship and the single screw of the steamship. Basin tests of a single propeller placed in the normal position abaft the stern post and of twin screws placed out in free water have shown that the twin propellers can work with a very much higher speed and still attain the same efficiency as the slow running single propeller. It should also be expected that the propulsive power in a seaway would be better maintained with two small deeply submerged propellers than with one large single propeller, which very likely will be lifted partly out of the water when the ship pitches.

Trials with sister ships—one with a single slow speed steam engine and another with higher speed twin screw Diesel engine installations—have been carried out both in England and in Sweden and have both shown that the twin screw arrangement is superior to the single screw, based on same shaft horsepower. In order not to complicate matters, the efficiency is here considered equal in both installations.

The Machinery Weights

The *machinery weight* of the steam installation is estimated at 550 tons and that of the Diesel installation at 630 tons, the difference, 80 tons, being in favor of the steamship. Taking the total deadweight capacity of the steamship to be 10,000 tons, then the question of machinery weights can be eliminated from further consideration by taking the value 9,920 tons for the motorship deadweight capacity.

The cargo capacity deadweight will be 10,000 tons for the steamer, or 9,920 for the motorship, less the sum of the weights of bunker fuel, water and stores for each ship, and the numerical value of these items must be separately determined.

Stores

Stores for deck, engine and steward's department are estimated at about one ton per day for each ship, and while considerable variation in this figure is possible, even the largest reasonable value is so small a part of the total deadweight that it is hardly worth discussing.

Fresh Water

Fresh water is required on both vessels for drinking and washing, the amount required being, at an outside figure, about twenty gallons per man per day with little or no reserve. Assuming a crew of about forty men all told, the nearest round number is three tons per day for each ship. In addition, the steamship will require some make-up water to equalize losses, and this is estimated at ten tons per day, or about 2 percent of the boiler evaporation, to be carried in tanks. The total water for the motorship depends on the number of days for which water must be carried, while for the steamship the number of days at sea determines the total make-up water. This factor of days at sea vs. days in port per voyage or per year also enters into the total items and is worth some study.

Sea days, in relation to *lay days*, depend on the length of the voyage, the speed of the vessel at sea and the estimated time of lading, unloading or waiting for cargo while lying in port. These same factors determine the total time of a round trip or turnaround, and the number of voyages per year. While almost any figure might be assigned to *lay days* as a matter of opinion, it is clear that whatever value be chosen, the ratio of *sea days* or *steam days* to the former will be greater the longer the voyage. The accompanying tables indicate this clearly, the first one being for the speed of the ship under consideration, the second for a faster vessel and different conditions.

TABLE 1.—SCHEDULE FOR 11-KNOT VESSEL

Voyage	Days: Lay	Days: Steam	Turnaround: Days	Turnaround: Miles	Voyages per Year (10 Days Overhaul)
New York to	10				
Liverpool to	21	12.5			
New York	11	12.5			
6,439 miles	42	25.0	67	6,439	5.3
New York to	10				
Buenos Aires to	21	22.5			
New York	11	22.5			
11,740 miles	42	45.0	87	11,740	4.1
New York to	11				
South Africa to	21	30.5			
New York	11	30.5			
16,000 miles	43	61.0	104	16,000	3.4

TABLE 2.—SCHEDULE FOR 12-KNOT VESSEL

Voyage	Days: Lay	Days: Steam	Turnaround: Days	Turnaround: Miles	Voyages per Year (25 Days Overhaul)
New York to	6				
Liverpool to	11	11.5			
New York	7	11.5			
	24	23	47	6,439	7.23
New York to Cape Town	10				
Cape Town to	4½	32			
Algoa Bay to	4½	2			
E. London to	4½	1			
Port Natal to	4½	1			
Cape Town to	4	3			
New York	11	33			
	43	73	116	15,228	2.93
New York to	10				
Sydney to	7	37			
Melbourne to	13	2			
New York	10	38			
	40	77	117	20,217	2.9
New York to	10				
Panama to	1	9			
Yokohama to	3½	27			
Kobe to	4	1½			
Shanghai to	5½	3			
Hong Kong to	7	3			
San Francisco to	1	13			
Panama to	1	24½			
New York	11	9			
	44	90	134	23,291	2.54

From the figures of the schedule of Table 1, the total weights of water to be carried in tanks for each of the three typical voyages are stated in Table 3.

TABLE 3.—WEIGHT OF WATER IN TANKS—LONG TONS

Voyage	Item	Steamship: Out	Steamship: In	Motorship: Out	Motorship: In
New York to Liverpool and return	Water per day.	13	13	3	3
	Days' supply...	12.5	12.5	12.5	12.5
	Total required..	162.5	162.5	37.5	37.5
	Reserve	12.5	12.5	2.5	2.5
	Total in tanks..	175.	175.	40.	40.
New York to Buenos Aires and return	Water per day.	13	13	3	3
	Days' supply...	22.5	22.5	22.5	22.5
	Total required..	292.5	292.5	67.5	67.5
	Reserve	32.5	32.5	7.5	7.5
	Total in tanks..	325.	325.	75.	75.
New York to South Africa and return	Water per day.	13	13	3	3
	Days' supply...	30.5	30.5	30.5	30.5
	Total required..	396.5	396.5	91.5	91.5
	Reserve	43.5	43.5	8.5	8.5
	Total in tanks..	440.	440.	100.	100.

Fuel

Fuel is the most important of the deadweight items, not only because it is the largest, but also because in it are found the largest differences between steamships and motorships. As it is assumed that the steamship will burn fuel oil and that both ships will have double bottom tanks, the comparison can be made directly. The weight required must be calculated from the fuel consumption of the main engines and auxiliary machinery at sea and that of the auxiliaries in port, and the bunker or tank capacity for a given voyage or radius of action for given bunkers and tanks from the density of the fuel oil of different grades obtainable.

While any oil may be classed as fuel oil, it is common practice to regard oil at or near 16 degrees Baume as low grade and suitable for boilers, and oil at or near 22 degrees Baume as high grade and suitable for internal combustion engines. The lighter oils with large Baume numbers usually bring higher prices because of the greater ease in handling them, due to greater fluidity and freedom from dirt. Therefore, while Diesel engines can use any oil that can pass through the pumps, it is considered worth while to pay a little more for the lighter, cleaner, more fluid oils, to avoid the necessity for heating the heavier viscous oil to make it flow and subsequently filtering and settling to clean it. On the other hand, with boilers, when a little heat more or less matters but little and dirt is less serious in oil, it is customary to buy a cheaper oil. However, even here there are exceptions, some engineers and owners having come to the conclusion that a little better grade of oil is worth the comparatively small increase in price.

In this comparison it is assumed that 16 degrees Baume oil will be used for the boilers and 22 degrees Baume oil for the internal combustion engines. These oils, according to Table 4, weigh 7.994 pounds and 7.677 pounds per

United States gallon, or 335.74 and 322.43 pounds per 42-gallon barrel respectively. The former requires 6.67 barrels per long ton of 2,240 pounds and the latter 6.95 barrels.

Supplies of oil are now becoming available at an increasing number of points reached by ships throughout the world, as shown in Appendix Table 18, which gives a partial list of such fuel oil stations maintained by various oil companies.

TABLE 4.—FUEL OIL WEIGHTS

Baume	Pounds per Gallon	Pounds per Barrel (42 Gallons)	Barrels (42 Gallons) per Ton — Short (2,000 Pounds)	Barrels (42 Gallons) per Ton — Long (2,240 Pounds)
14........	8.102	340.28	5.877	6.583
15........	8.052	338.18	5.914	6.624
16........	7.994	335.74	5.957	6.672
17........	7.935	333.27	6.001	6.721
18........	7.885	331.17	6.039	6.764
19........	7.835	329.07	6.078	6.808
20........	7.777	326.63	6.123	6.858
21........	7.727	324.53	6.163	6.902
22........	7.677	322.43	6.203	6.947
23........	7.627	320.33	6.243	6.993
24........	7.577	318.23	6.285	7.039
25........	7.527	316.13	6.326	7.086
26........	7.477	314.03	6.369	7.133
27........	7.435	312.27	6.405	7.173
28........	7.385	310.17	6.448	7.222
29........	7.344	308.45	6.484	7.262
30........	7.294	306.35	6.528	7.312

As the double bottom bunkers of the motorship can hold sufficient oil for about 20,000 miles, it is evident that this type of vessel is more independent of the location of these fuel oil stations than is the steamer.

Fuel consumption in pounds per hour per shaft horsepower can be pretty accurately predicted for main engines from data on hand, and the same is true for engine room auxiliaries, or the total for all purposes at sea. There is, however, considerable latitude in estimates of port requirements for cargo handling and general ship purposes. This is not serious, however, as the amount is small in comparison with consumption at sea, except for those cases where the ship is operated on short runs with very long port stays, a quite special case. No extraordinarily low figures obtained on trial trips, or with machinery in abnormally fine condition in the hands of builders' experts trying to make a record, can be accepted in estimates of commercial ship operation. For this purpose the fuel consumption figures must be those obtainable in every-day service with engine room crews of average quality and skill.

Fuel Consumption for Diesel Engines

The fuel consumption of a Diesel engine is a very definite figure, and so long as the exhaust is clear there is absolutely no difference in the consumption during ordinary tests in the shop, or at any time in service in the ship. The consumption in large four cycle Diesel engines is about 0.41 pound of fuel oil per shaft horsepower. To this figure has to be added the fuel consumption of the auxiliary engine generating electricity for motor driving the pumps, the separate compressors, the steering gear and for the electric lights. The power required for this service at sea is about 50 brake horsepower; the consumption in these smaller engines is about 0.44 pound per brake horsepower, whereby the total consumption of a 2,700 shaft horsepower plant will be

$$\frac{(2{,}700 \times 0.41) + (50 \times 0.44)}{2{,}700} \doteq 0.42$$

pound per shaft horsepower. Adding about 7 percent for incidental losses or waste, there is obtained 0.45 pound per shaft horsepower for all purposes at sea. The total per day for all purposes at sea for the motorship is, therefore, $2{,}700 \times .45 = 1{,}215$ pounds per hour, = 29,160 pounds per day of 24 hours, $= \frac{29{,}160}{322.4} = 90$ barrels of 22 degrees Baume oil, $= \frac{29{,}160}{2{,}240} = 13$ long tons.

In port, the motorship may use one or all of its one, two or three auxiliary Diesel engine generating sets, supplying current for all purposes, including electric winches for cargo handling. A total of 2,000 brake horsepower hours per day of auxiliary engines will carry all reasonable winch loads on a 10,000-ton ship, with the ship's lighting and pump service. This is equivalent to an average of 150 brake horsepower for 10 hours for hoisting or lowering and 21 brake horsepower for 24 hours for ship service. This total power requires $2{,}000 \times .44 = 880$ pounds fuel per day $= .4$ long ton $= \frac{880}{322.4} = 2.7$ barrels in round numbers.

Fuel Consumption for Turbine Installation

Steam machinery fuel consumption estimates are subject to much wider variation, as they may easily differ one from another by 100 percent, due to differences in design or in condition in which the boiler and machinery is maintained. As the geared turbine is considered a highly economical equipment with high pressure superheated steam and good vacuum, it is taken as a basis of comparison. While test water rates of 12 pounds are obtained for these turbines, with boiler evaporation of 14 pounds steam per pound of oil or better and 12 percent of turbine steam or less for auxiliaries, actual ship service with present-day crews is not so good. Losses in boiler efficiency, losses in vacuum, steam for heating the viscous fuel oil and other similar items will require more fuel. A fair service water rate would be 13.6 pounds of steam per hour per shaft horsepower for the turbine and 14 percent of this or 1.9 pounds per shaft horsepower for auxiliaries, making a total of 15.5 pounds per hour per shaft horsepower. This is equal to $15.5 \times 2{,}700 = 41{,}850$ pounds of steam per hour, or about 450 long tons per day. A fair service value for evaporation is 13 pounds steam per pound of oil, so the oil consumption is $\frac{41{,}850}{13} = 3{,}220$ pounds per hour $= \frac{3{,}220}{2{,}700} = 1.2$ pounds per hour per shaft horsepower. This is equivalent to $24 \times 3{,}220 = 77{,}280$ pounds per day = 34.5 long tons per day $= 34.5 \times 6.67 = 230$ barrels for 16 degrees Baume oil. This is 2.65 times the motorship requirement by weight and 2.55 times by volume.

Steamship fuel oil consumption in port is proportionately large, because steam winches have very high water rates, as is well known, and there is considerable condensation in the long steam pipes. A conservative estimate is 5 pounds of fuel oil per brake horsepower, and for the 2,000 brake horsepower hours of port service per day the oil required will be 10,000 pounds or 4.5 long tons = $4.5 \times 6.67 = 30.0$ barrels.

The fuel item of the deadweight can now be calculated for the three typical voyages, and it will be assumed that oil is to be carried for a round trip and with some reserve. These figures are given in Table 5 and the reserve is estimated at about one-eighth of that required for consumption outbound.

TABLE 5.—WEIGHT OF FUEL IN BUNKER TANKS—LONG TONS

Voyage	Item	Steamship Out	Steamship In	Motorship Out	Motorship In
New York to Liverpool and return 6,439 miles	Fuel per day in port	4.5	4.5	.4	.4
	Port fuel, 42 days	189.0	94.5	16.8	8.4
	Fuel per day at sea	34.5	34.5	13.0	13.0
	Sea fuel, 25 days	826.5	431.3	325.0	162.5
	Total required	1,051	526	342	171
	Reserve	129	129	38	38
	Total carried	1,180	650	380	210
New York to Buenos Aires and return 11,740 miles	Fuel per day in port	4.5	4.5	.4	.4
	Port fuel, 42 days	189.0	94.5	16.8	8.4
	Fuel per day at sea	34.5	34.5	13.0	13.0
	Sea fuel, 45 days	1,552	776	585	293
	Total required	1,741	871	602	301
	Reserve	219	219	78	78
	Total carried	1,960	1,090	680	380
New York to South Africa and return 16,000 miles	Fuel per day in port	4.5	4.5	.4	.4
	Port fuel, 43 days	193	97	17.2	8.6
	Fuel per day at sea	34.5	34.5	13.0	13.0
	Sea fuel, 61 days	2,105	1,052	793	386
	Total required	2,298	1,149	810	395
	Reserve	287	287	100	100
	Total carried	2,590	1,440	910	500

The cargo capacity deadweight is determined by subtracting from 10,000 tons the sum of each of the items of deadweight separately computed, fuel, water and stores, and these figures are collected in Table 6. It is apparent from the table that in spite of a handicap of 80 tons excess machinery weight, the motorship has in all cases a greater cargo carrying capacity than the steamship, because of its low fuel consumption. It is also clear that this difference is greater for the longer voyages by increasing margins, which again indicates the special superiority of motorship for this long voyage class of service.

TABLE 6.—DEADWEIGHT DISTRIBUTION AND CARGO CAPACITY

Voyage	Item	Steamship Out	Steamship In	Motorship Out	Motorship In
New York to Liverpool and return 6,439 miles; 42 lay days, 25 sea days, 67 total days	Fuel in bunkers	1,180	650	380	210
	Water	175	175	40	40
	Stores	70	70	70	70
	Excess machinery Weight			80	80
	Total	1,425	895	570	400
	Total deadweight capacity	10,000	10,000	10,000	10,000
	Deadweight cargo by difference	8,575	9,105	9,430	9,600
New York to Buenos Aires and return 11,740 miles; 42 lay days, 45 sea days, 87 total days	Fuel in bunkers	1,960	1,090	680	380
	Water	325	325	75	75
	Stores	90	90	90	90
	Excess machinery Weight			80	80
	Total	2,375	1,505	925	625
	Total deadweight capacity	10,000	10,000	10,000	10,000
	Deadweight cargo by difference	7,625	8,495	9,075	9,375
New York to South Africa and return 16,000 miles; 43 lay days, 61 sea days, 104 total days	Fuel in bunkers	2,590	1,440	910	500
	Water	440	440	100	100
	Stores	100	100	100	100
	Excess machinery Weight			80	80
	Total	3,130	1,980	1,190	780
	Total deadweight capacity	10,000	10,000	10,000	10,000
	Deadweight cargo by difference	6,870	8,020	8,810	9,220

SUMMARY

	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
Liverpool, 5.3 voyages per year, cargo tons	17,680	93,704	19,030	100,859
Buenos Aires, 4.1 voyages per year, cargo tons	16,120	66,092	18,450	75,645
South Africa, 3.4 voyages per year, cargo tons	14,890	50,666	18,030	61,302

Bulk cargo (measuring over 40 cubic feet per ton) conditions are also favorable to the motorship, as the following figures will show. The engine room of the motorship carrying all the machinery except deck gear is shorter than the combined engine and boiler rooms of the steamship.

(To be concluded.)

Electric Propelling Machinery of Future United States Capital Ships

THE present naval programme of the United States is the most extensive ever undertaken by any nation. We are now rapidly completing six battleships of the *Tennessee-New Mexico* class, and while these vessels are today unequalled in military power, they will become secondary as soon as representatives of two new classes are put into commission.

These new classes consist of battleships and battle cruisers, which will compare with the *Tennessee* as follows:

	Tennessee	New Battleships	New Battle Cruisers
Length overall, feet	624	684	874
Beam, feet	97	105	90
Draft, feet	31	33	31
Displacement, tons	33,000	43,200	43,500
Speed, knots	21	23	35
Main battery	12 14-inch guns	12 16-inch guns	8 16-inch guns
Shaft horsepower	30,000	60,000	180,000

The new battleships are to be electrically driven, and the main propelling equipment of four of them—the *Indiana, Montana, South Dakota* and *North Carolina*—will consist of two Westinghouse 28,000-kilowatt turbine generators and four 15,000-horsepower Westinghouse propeller motors. The turbines are to be of the complete expansion, impulse-reaction type, and will develop their full rated load at 265 pounds steam pressure, 50 degrees superheat, and 28½ inches vacuum. Electric power will be generated in the form of 3-phase, 60-cycle, 5,000-volt alternating current.

The statistics of the new battle cruisers given in the table indicate that these vessels are to be very unusual in many respects, but their most remarkable feature is the enormous power of their turbines—180,000 horsepower, or 160,000 kilowatts.

These figures do not, however, give an adequate conception of the magnitude of this power. Not only is it greater than that of any ship ever designed—for the power of the British cruiser *Hood* is 134,000 horsepower and that of the *Leviathan* 90,000 horsepower—but it is greater than that used by most cities of over a half a million inhabitants.

Two of these vessels, the *Ranger* and the *Constellation,* will have the following equipment:

Four Westinghouse main turbines to develop 49,750 brake horsepower each, with steam at 265 pounds, 50 degrees superheat, and 28½-inch vacuum.

Four 40,000-kilowatt Westinghouse generators, directly connected to these turbines and generating 3-phase, 51.3 cycles, 5,400-volt alternating current.

Eight wound-rotor Westinghouse motors (two to each propeller), which are to be rated at 22,500 horsepower each, and will be the largest in the world.

Fig. 1.—S. S. *Comanche* After Being Reconditioned

Rebuilding the Steamship Comanche

The rebuilding of the S. S. Comanche of the Clyde Steamship Company, New York, recently completed by the Tietjen and Lang Dry Dock Company, Jersey City, N. J., was one of the biggest alteration and repair jobs ever turned out by a shipyard. With the co-operation of Theodore E. Ferris, naval architect for the Clyde Steamship Company, the work was taken in hand and practically a new steamship was turned out by the men at the Tietjen and Lang yard.

DUE to the hard service in which the Clyde liner *Comanche* had been used by the Government and the little opportunity for repairs, even of a minor nature, there was much to be done when she was taken in hand for overhauling. Because of the extensive changes in the arrangement of the vessel she was "inclined" or heeled at the dry dock, so that the designer could determine the exact center of gravity of hull and machinery. This was done before anything was changed from the old rig.

Given free hand, the Tietjen and Lang men then stripped the hull down to the hurricane deck. Men were busily engaged in cleaning the outside of the hull plating while she was in dry dock, scaling and painting. The propeller and tail shaft were carefully examined and any parts that showed signs of wear were replaced by new fittings.

Machinery Overhaul

The main engines, which are of the reciprocating type, were given attention by the shipyard machinists, the cylinders being re-bored and other parts of the machinery being overhauled and replaced where needful. The condensers received new tubing and all auxiliary pumps were taken out and new ones put in their place.

A new engine room skylight was built, giving plenty of

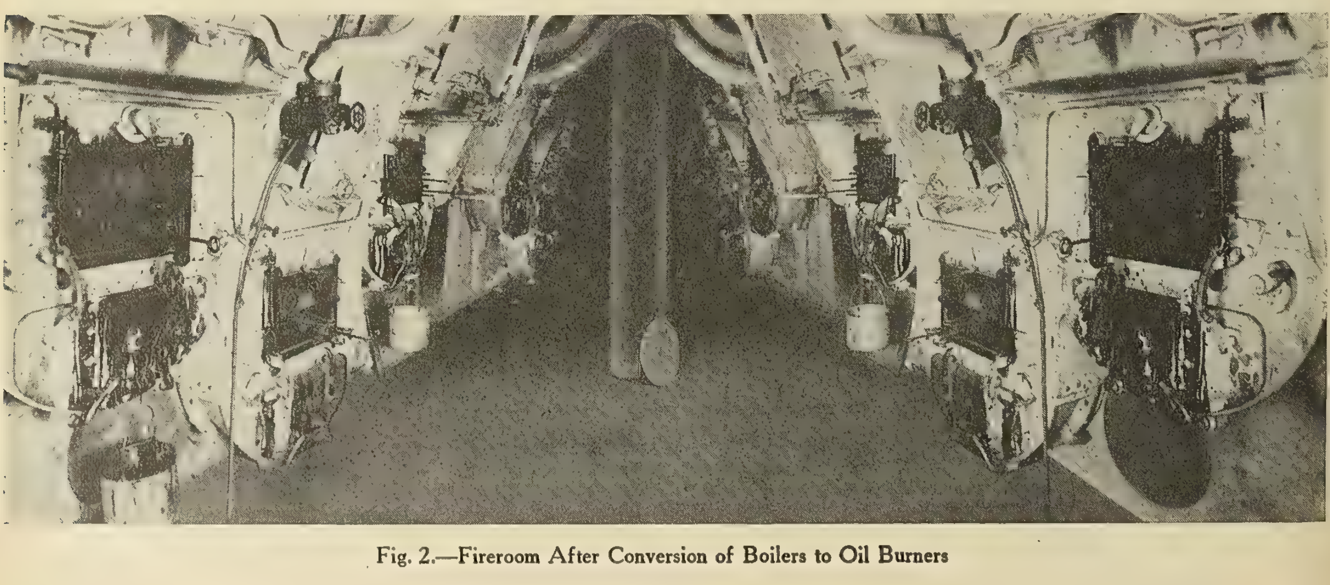

Fig. 2.—Fireroom After Conversion of Boilers to Oil Burners

Fig. 3.—Main Stairway

Fig. 4.—Dining Saloon

light and air to the force below. Gratings and ladderways lead from the operating platform up to the quarters of the engineers and oilers.

Converted to an Oil Burner

One of the big changes in the new arrangement consisted in altering the fuel system from coal to oil burning in the boilers. The old boilers were taken out and four new ones installed in their places. These were designed to burn fuel oil with nozzles fitted with the White Fuel Oil Engineering Corporation patent type.

In order to accommodate the new fuel it was necessary to make alterations in the existing bulkheads and a number of new ones added to suit the special requirements for oil storage, such as room for expansion, swash plates, etc. As it was desired to have at least 3,000 miles steaming radius, space was required for about 390 tons of oil.

New Piping System Installed

With the placing of the new boilers the pipe shop gang of the shipyard was given a large amount of work in fitting a new system of piping for steam and carrying of the oil fuel from tank to tank and from tank to boilers. Practically all of the old piping was taken out of the ship and new material put in place. The necessary pumps for handling the oil were installed as new fittings. Piping for supply and discharge as well as to heat the oil was carried all through the various tanks and wells, this being a big job in itself.

With new cowl ventilators and a new boiler hatch the force in the boiler room is now given light, air and good working conditions. Many of the firemen now attend to their duties clad in white canvas clothes.

The hull of the vessel remained intact except for the renewal of ten plates amidships, on both sides of the hull.

Changes in the Hull

In No. 3 cargo hold the frames and reverse frames were taken out and new ones fitted in their places. In order to carry the strength of the ship up to the additional decks many of the main frames were cut at the main deck and spliced with an extra length.

Above the hurricane deck the vessel was entirely rebuilt. In order to sustain the extra weight when in a heavy seaway and to resist the racking strains which come at such a time, additional web frames were fitted about twenty feet apart for a considerable distance in the length of the ship.

Fig. 5.—Lounge

An entirely new promenade deck, carried out to the side of the vessel, was built as a "joiner deck," that is, with wood planking and steel tie plates along the edges of the deck and deck openings.

Accommodations

On the old hurricane deck a wood deck house was carried amidships and in it was built some of the first class staterooms and dining room. The main dining room is an attractive compartment, located in the forward end of the house. There are many airports which give plenty of light and ventilation. Electric fans are so placed as to give a steady current of cool air to those at the inner tables while the arrangement of electric light fixtures is pleasing to the diners.

The chairs, of pleasing design, light and well upholstered, are secured to the deck by a turnbuckle so they may be easily removed and yet are steady when the ship is in a seaway. By using this kind of furniture the heavy, massive appearance so often seen on ocean-going steamers has been avoided. The tables have been arranged to seat four or six people. The whole atmosphere of the room is light and airy. The mahogany sideboard is finished in natural color, all the paint work is a dull white, the panels of the ceiling being lined with gold stripes. The small serving tables near the dining tables are fitted with steam coils under them, serving to keep them warm and also to heat the room.

The pantry and galley, with its bakery, scullery, new cooking ranges, steam tables for keeping the food hot and rows of dishes are in keeping with a well-ordered ship. Sanitary tiling on the deck helps to keep it all neat and clean.

The officers' mess room is just aft of the galley and the sailors' mess room aft of that again, thus making the problem of feeding the ship's company very easy and simple.

As these mess rooms are on the port side, there is provision for a long passageway from the main dining room, aft to the stern, passing staterooms and social halls.

There are a few such social halls located in convenient corners having a table and a few chairs where passengers may sit and chat or write, as they may please.

First Class Staterooms

The first class staterooms, of which there are one hundred and five, including ten suite rooms, have two berths, settee, toilet, basin, mirror and locker. The curtain hanging in front of the air port gives a pleasant look to the interior, and with the white bulkheads, mahogany trim to the blinds and front of berths and carpet on the floor it compares well with any of the large transatlantic liners.

The suite rooms have either two single beds or one large double bed. A full length mirror fastened to the bathroom door, electric fan, four or five electric lights, wall and dome, make it very comfortable for the voyager. The bathrooms are large and well equipped with toilet and tub, shower with hot and cold fresh and salt water.

Promenade and Boat Decks

Above the promenade deck a similar wood deck house has been built and above it the boat deck. In the forward end of this deck house the lounge is located, being attractively furnished with piano, chairs, settees and writing tables. From here one may obtain a fine view ahead, looking over the forecastle.

A long passage on this deck connects the lounge with all of the passenger staterooms on the same deck. Two large stairways serve the two decks for use of the passengers. These have mahogany rails, art iron balustrade and heavy brass nosings and kick plates.

The steerage passengers are accommodated aft on the main deck. The men have a large compartment fitted with beds on one side of ship and eating tables on the other side. The women are on the deck above and have four-berth staterooms. They have a separate mess room from the men and are well provided for.

As all of the accommodation for passengers has been entirely rebuilt, it has been necessary to install a complete new system of ventilation for the staterooms as well as new plumbing and sanitary systems, together with their fittings.

The boat deck has been carried out to the ship's side to accommodate the stowage of the lifeboats. There are four patent lifeboats and ten steel boats of the regular type.

Officers' Accommodations

The large and well-arranged pilot house is finished in quartered oak as well as the captain's cabin, which is just abaft it. On the boat deck, cabins for the ship's officers have been built so they are comfortably situated, with baths and showers in special compartments. The captain's cabin has a separate bathroom for his use.

A new forecastlehead has been built and serves to house the stewards and other mess attendants, the forecastle deck being fitted with the usual deck gear.

The Smoking Room

The smoking room, headquarters for the veteran sea-voyager, is on the boat deck and is one of the most attractive rooms on the ship. A regulation "bar" of the pre-war type is built on one side. Well-designed built-in seats with card tables conveniently placed are suited to the most exacting taste. The quartered oak finish of the room is well set off by square windows having nine small lights of glass. Curtains in front of these windows are drawn back, giving plenty of light to the interior. This is added to by the large light-well which is carried up through the center of the room.

Swivel chairs are secured at the sides of the card tables. Electric lights in the shape of balls are secured to the sides, while above dome lights help to give a bright appearance to the room.

A tile finish on deck is set off by panels on the ceiling, these being divided into squares by oak strips. All paneling on the ship is a patent fibre board, very hard and one which takes the paint with good effect.

Aft of the smoking room is the shelter deck, so-called, as it is really a large room with the after end left open for air and a fine view of the ship's wake. The sides of the room are protected by walls fitted with glass sides, but the end is all open to the weather. The wood here is of teak, finished bright. For the benefit of the passengers in rainy or hot weather a heavy awning is stretched over the end of the boat deck so that passengers from the smoking room may pass out onto a weather deck without inconvenience.

To offset the additional superstructure, about one hundred tons of ballast was added, with the result that the ship is now "steady as a church" in a heavy sea and is winning praises from her navigating officers.

The *Comanche* as she now floats is as good as a new ship to her owners.

Annual Meeting of American Society of Mechanical Engineers

THE 1920 annual meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th street, New York City, from December 7 through December 10. Sessions will be held on the subjects of Appraisal and Valuation and the Application of Engineering to Woodworking. The newly founded Professional Sections on Management, Power, Fuels, Machine Shop, Railroads and Textiles will also conduct sessions to consider the vital problems in their field. In addition, a number of valuable papers will be presented at General Sessions. A memorial session for Dr. Brashear is planned as a fitting tribute to his life and work.

The executive committee of the Metropolitan Section of the Society has decided to hold a series of joint meetings throughout the year with the New York Section of The American Institute of Electrical Engineers. In general the subjects selected for these meetings will come under the following classifications: Marine Engineering, Engineering Education, Industrial Installations, Power Generation, Steam Railroad Electrification, and Industrial Relations. It is intended to hold the first meeting in October.

The Cost of Inefficiency at Our Terminals

BY HARWOOD FROST*

One of our favorite topics of conversation of late has been the high cost of living. As a contributory cause of no small importance to this distressful state of affairs, Mr. Frost estimates an annual waste of no less than $400,000,000 *at our terminals due to inefficient equipment and methods. Figured as interest at* 5 *percent, this represents a capital sum of* $8,000,000,000 *tied up by inefficiency in handling freight. Such waste is preventable and the author indicates the way in which it can be eliminated.*

WE have been told that the high cost of living is caused by profiteering, by high labor costs, by underproduction, by the excess profits tax, by inflation, extravagance and other causes, most of which can be traced directly or indirectly to the war. No one or two of these factors can be said to be *the* cause of high prices. They, with many others, are all contributory, and among these other factors are the wastes involved in the traffic in goods or in the handling of materials in transfer.

The railroads and the water routes are the lanes over which the traffic passes, but the ends of these lanes are our railroad and marine terminals, and through them passed goods representing last year a commerce of nearly ninety billions of dollars, representing a per capita expenditure of $806.

$30,000,000,000 Wasted Through Inefficiency

It has been stated by authorities that of this expenditure about *one-third*, or a total of between 25 and 30 billions of dollars, can be traced to inefficiency and preventable wastes in our methods of handling materials in transfer from producer to consumer. This enormous sum—a sum much greater than the total issue of Liberty Bonds—is incorporated in our expenditures by a system of multiplication and addition in the progress of commodities from the source, through the hands of the middleman, to the consumer. It plays an important part in making up our present high cost of living, largely because of indifference of shipping interests, political influence and ignorance of the general public to the conditions which exact this burdensome and unwarranted tax.

Waste in materials-handling methods hampers production and there cannot be any doubt that this unnecessary tax of between 25 and 30 billions of dollars has a most serious effect on one of our great problems—underproduction.

The handling of commodities is purely a non-productive expense. No amount of lifting and hauling increases the quality or the intrinsic value of the article. The ultimate price depends on transportation and handling. As the goods pass from producer to consumer through the hands of wholesalers and jobbers each adds his profit in addition to his expenses; as the bags or other packages are loaded into cars or ships, unloaded and trucked across docks and warehouses, piled for storage and otherwise handled, each handling increases the ultimate cost.

> An important reason for the neglect in providing mechanical equipment at our terminals is the skepticism of managers, foremen and contractors in charge of terminal and warehouse works, who have, in many cases, grown up from the ranks and have never considered the subject beyond the limitations of their own experience. This ignorance and skepticism can often be extended to embrace those in higher authority, especially where the control of the terminal is subject to political influence. At some of our ports the authorities are planning to spend vast sums for new piers and harbor facilities, with little or no regard to provisions for economy or speed in the handling of the freight. The result will be that the whole nation must suffer and pay for this lack of efficiency in our terminal facilities.
> —*Harwood Frost.*

Possible Savings in Rail Transportation

The railroads of the United States handle under normal conditions over one billion tons of miscellaneous freight annually, as was shown in the Interstate Commerce Commission report of 1914, the handling of which, not including the rail haul, costs from a few cents up to 50 cents per ton, and in some special cases much more, depending on many varying conditions. It is asserted that from ten to thirty cents a ton can be saved by the introduction of mechanical equipment, which would indicate, at an average saving of even 15 cents a ton, a saving to the railroads of about $150,000,000 a year on each handling. As all this freight is handled at least twice, the possibilities in saving would be double this figure—$300,000,000 per annum. The facts are, however, that much of this freight is handled five, six, seven or eight times, exclusive of the hauling.

And yet there is not one single railroad terminal in the United States completely and efficiently equipped with mechanical appliances for the handling of package freight.

Our Wasteful Marine Terminals

In the marine field it is estimated that under normal peace-time conditions, considerably over 300,000,000 tons of miscellaneous freight are handled at our seaport terminals every year. The conditions of handling in this field and the costs are essentially the same as in the case of the railroad terminals, so with an average reduction in cost of 15 cents per ton there would be an approximate annual saving of $45,000,000 on each handling, and as this freight also must be received inward and shipped or delivered outward, the possible saving would be ninety million. Add to this $10,000,000, which is a most conservative estimate of the saving that might be effected in handling the vast tonnage of our inland waterways and lakes, and we have a possible saving of one hundred million dollars a year in the terminal handling of our water-borne commerce.

And yet there is not a single marine terminal in any one of the hundreds of ports in the 5,000 miles of sea coast of the United States, nor a single lake or river port in the thousands of miles of our navigable waterways completely and efficiently equipped for the handling of package freight.

* President, Brown Portable Conveying Machinery Company, Chicago, Ill.

If these figures may be considered as even approximately correct, the railroads can save $300,000,000 every year by improved methods and the steamship and steamboat companies can save another $100,000,000 a year. In other words, the transportation or terminal operating companies of the United States are unnecessarily wasting $400,000,000 of their stockholders' money every year by lack of efficient handling methods.

$400,000,000 Wasted Annually

The savings effected by a properly co-ordinated system of mechanical freight handling equipment run from 10 to 80 percent, according to the many conditions affecting each particular installation, but 40 percent may be considered as a fair average. If we assume the average possible reduction of 15 cents per ton in the expense of each handling to be represented by this 40 percent, then this $400,000,000 would represent an expenditure for labor alone of about a billion dollars a year, which is actually less than the amounts so expended at our terminals.

Labor-Saving Machines Pay Their Way

Experience has shown that where labor-saving machines of this nature are in fairly continuous use, the savings they effect will repay the investment in from six to eighteen months. From this rough basis we may estimate that the value of the equipment necessary to effect a saving of $400,000,000 a year, repaying its cost in approximately fifteen months, would be $500,000,000—only 6 percent of the labor investment represented in the annual waste, only half of the actual labor cost of one year, and only 2½ percent of the amount of Liberty Bonds bought by the American people.

> Large sums have been appropriated for the improvement of American harbors, for the construction of new piers and the improvement of old, for the building of terminal warehouses, and for the installation of equipment. Millions will be spent on these improvements; but, unfortunately, millions will also be wasted by incompetent advice and improper design of warehouses and handling equipment, due largely to lack of experience and lack of education in this field of engineering, and also through lack of unselfish co-operation among manufacturers. The shortage of labor calls for the use at our ocean, lake, gulf and river terminals of winches, hoists, telphers, battery trucks, tractors and trailers, tiering machines, conveyors and all other possible devices that will utilize manual labor in the smallest degree; that will not only hoist or lower the freight between the dock and the vessel's hold, but that will transfer, tier and reclaim, and that will do so at such a speed as to materially reduce both the time of actual handling of this cargo and the idle time of the carrier.—*Harwood Frost.*

But this is not all; these figures refer to labor only. Add to this possible saving of labor the savings due to quicker deliveries of goods, the saving due to quick release of cars, ships and trucks, the elimination of damage to packages, the prevention of loss of perishable freight, etc., and you can well realize that any substantial proportion of these combined savings for a single year would be sufficient to pay for the erection and complete equipment of a large number of terminals, and that the elimination of such wastes would mean the transfer of thousands of laborers from non-productive to productive work.

Terminal Expenses Many Times the Cost of Hauling

It has been estimated that the average expense of hauling a ton of freight 240 miles is 74 cents, while the average expense of handling the same ton of freight at the terminals is 75 cents; that is, the terminal handling charges equal the freight haul of 240 miles. As an example of the expenses involved in the short haul from New York to Philadelphia by rail, the cost of handling at the terminals is $3.65 and the railroad cost for the 90-mile haul is 27 cents. The terminal expenses are nearly fourteen times the rail haul.

It costs as much to deliver a shipment from a freight terminal in New York to the hold of a ship as it does to transport it by rail from Chicago to the New York terminal. The 1,300-mile marine haul from Havana to Boston is cheaper than the transfer from one pier in Boston Harbor to another. It costs more to load a box of canned goods on a car in Chicago than it does to carry it by rail from Chicago to New York. It costs more to transfer a barrel of flour over the wharf and to the hold of a ship in New York than to carry it by that ship from New York to Liverpool. It is said that the waste caused by idleness of motor trucks at terminal points due to inefficient loading methods and congestion is over $250,000,000 a year.

New York, where half the nation's imports and exports are handled, is planning to build a terminal practically devoid of modern materials-handling appliances. New York plans to spend many millions of dollars on docks of exactly the size and type built in the days of the "clipper ship," with no regard to a possible decrease in handling costs to America's manufacturers and distributors.

But we are all paying our tax for New York's inefficiency in the price of every pound of sugar we eat, every cigar we smoke, every cup of coffee we drink; we are paying for it daily in every dollar we spend. It cannot be said that the terminal problem is a local one that affects New York, Seattle or New Orleans only. It is a national problem that affects every one of us.

Where Real Economy Can Be Secured

America has invented and manufactures more modern freight handling machinery than any other country in the world, and *uses* comparatively less. Still we are building up a merchant marine in an effort to compete for the world's trade and at the same time neglecting the very methods that made for the profitable operation of many foreign ports and that contributed largely to the normal low cost of living in these foreign countries.

Not until our terminals are properly designed with regard to the goods to be handled, and adequately equipped with machinery that will reduce both the time of the cargo and the idle time of the carrier, will we be able successfully to compete with these older, more experienced and more efficient maritime peoples, and only when the general public has been enlightened as to the economic effects of our present wasteful methods and aroused to the realization of its powers and responsibilities in the matter will we have efficiency in place of the present chaos and a terminal system that will be a credit to the engineering ability of the American people.

Terminal Improvements to Be Recommended.—Constructive recommendations looking to an improvement in the handling of freight in the terminals will be made soon by the railroad committee of the Chamber of Commerce of the United States. The suggestions are under preparation following a meeting of the committee at which a report on the terminal situation was made by its secretary.

Comment from the Shipping World

BY "OLD SCOTCH"

The merchant marine situation is now passing through a phase of uncertainty which is a natural sequence of after-the-war psychology. The troublesome times caused by the apparent success of the Russian miserables in the assault on Poland has for the time being unsettled the world's financial markets, already in a chaotic condition, but showing signs of recovery. Now, however, that the Shipping Board has announced a plan for the disposition of the Government-owned ships and several applications for the exemption of the war profit taxes to be used for the construction of new vessels have been made, it is hoped many new shipping and shipbuilding enterprises will be undertaken which have been held back on account of the adverse outlook.

IF people looked only on the dark side of situations as they arise, the world would make little advancement. Fortunately now, as at all times when things look darkest, there are some silver linings to the clouds of doubt and uncertainty which may seem to envelop us. Let us then be cheerful and consider that at times during the French revolution, which almost parallels present conditions in Russia, the world's affairs looked darker than they do today; yet out of it all came a decided advance in the stability of constitutional government. In spite of pessimistic forecasts by so many nervous observers who return to our shores it is not written in the world's horoscope that this seething mass of half-crazed Russians will undo the constructive work of centuries. Law and order are bound to prevail.

Notwithstanding the long delay, the new Shipping Board must eventually be appointed, and it is understood that the sales policy for the Board ships has practically been decided upon by the present members and will soon be promulgated. Ocean freight rates in common with all other inflated prices must naturally come down to normal conditions sooner or later. Hard times are generally the aftermath of over production, but the world is not suffering from any such condition—under production is the main trouble at present, and before normal conditions are arrived at there must be a tremendous amount of work performed by the human race, and ocean transportation will be one of the main activities.

Peak of High Costs Reached

Times such as the present are productive of good, inasmuch as it gets us in a humble mood and causes us to think over the future. The whole world is recovering from a protracted spree of riotous living caused by the inflations incident to the war. The "cold gray dawn of the morning after" has always resulted in firm resolves to do better. Let the marine world resolve to cut out the waste and profligacy of the past two or three years and get down to rigid economies in everything connected with shipping.

We must do it anyhow, if we are to continue our development of a merchant marine in all its functions. The Shipping Board is setting the pace, as its members realize the vital importance of making both ends meet, now as never before. Evidences of it are seen in every move at present. Agents abroad are cutting out the reckless expenditures heretofore encountered and getting down to brass tacks. The repairing of the ships is receiving closer scrutiny, and while nothing is being done to reduce efficiency, the new supervisory system is productive of great savings. The new insurance syndicates are functioning and already a great deal of the premiums heretofore placed abroad are being received by American companies.

While it is doubtful if the building costs of ships have been reduced, owing to the continued high prices for labor and material, we certainly have reached the peak of high costs and from now on cheaper costs may be confidently anticipated. The recent sale of two practically new Skinner and Eddy cargo ships to the Steel Corporation at a reported cost of about $144 per deadweight ton seems quite indicative of what the Shipping Board may have to fix as the selling cost of many of its ships. Under present circumstances it does not seem probable that any of this vast fleet will sell for much more than that rate per ton, with the almost certainty of gradually decreasing prices as the sale proceeds.

The Government, viewed in the light of a strictly business transaction, stands to lose a great deal of money, if the sales are consummated in accordance with the above assumptions, but that is not the correct viewpoint to take. Our fleet of merchantmen should be considered as a war expenditure, and if from a salvage standpoint the Government realizes only 50 percent from its investment in ships, it will get out of this investment much better than it has from any other of its major war expenditures. In addition to the returns of a direct monetary nature, there will be the indirect returns extending to all branches of industry in this country due to the rehabilitation of a merchant marine commensurate with the needs of our national business. This, we all must admit, could not have been accomplished without the expenditure of enormous sums in direct subsidies, so that viewed in a broad light Uncle Sam's investments in merchant shipping have not been so bad as some might imagine.

Bids for Naval Transport

Opinions as to the cost of ship production at the moment are very varied, but few authorities agreeing on the subject. Perhaps opinions backed up with bona fide bids for new construction are the most reliable, but even those are far apart, as evidenced by the proposals recently submitted for a naval transport. The proposed ship is to be 484 feet long, of about 10,000 tons displacement, and to have a sustained sea speed of 16 knots. With several exceptions caused by military necessities, she will not vary greatly from an ordinary passenger vessel of that size. Of the seven proposals received for her construction, the lowest one was from the Morse yard at Alexandria, Va., in the total sum of $2,493,000 with an agreement to complete the vessel in 16 months. The other bids mounted upward until the maximum estimate of $6,950,000 and 30 months for completion was recorded. This ratio of 2½ to 7 seems to represent in finite terms the indefinite ideas of shipbuilders generally as to the fluctuations of materials and labor for the next year or so. As before remarked, these be chaotic times we are passing through at this writing.

We have become so accustomed to enormous figures in money and commodities as incidents of the great war that nothing seems to surprise us. From a marine engineering standpoint, now that we have time to reflect, is there anything more stupendous to contemplate than the designed power of the new battle cruisers now under actual construction at several of our leading yards? Just think of 180,000 horsepower to be installed in one single ship! Perhaps we can better grasp the idea by considering that that amount of power would be sufficient to propel over half a million tons of the average-sized merchant vessels. The combined propelling power of no less than 70 of the Hog Island ships will just about equal the power that is to go in one of these battle cruisers. Let us hope that the Geological Survey will, in the meantime, get busy and discover more oil fields if these monsters are to cruise about to any great extent. In addition to these oil consumers, there are now building four new battleships of the ordinary dreadnought type, each to have 60,000 horsepower, sufficient to run fifteen of the largest merchant ships we have built. If fuel oil should continue its skyward course in price, who said there would be a reduction in our Federal income taxes in the next few years?

Aftermath of the Cup Races

Although the historic America's cup is to stay in our possession for at least another year, there seems to be a general public attitude of dissatisfaction concerning the outcome. In the first place the general public was precluded from witnessing the races because our laws relating to safety of ships at sea limited the sight-seeing craft to two or three high-priced observation craft. Added to that is the general fair-minded American attitude that one-sided events are not productive of the best in sportsmanship of this character. Above every other feature connected with the races was the postponement of one of the events solely because there was too much wind blowing. After repeated flukes and drifting matches, the average man interested in the sport was somewhat disgusted with the idea of there being too much of a desired element. The truth of the matter is that yachts designed for these great international events have degenerated into purely racing machines, designed for mild weather only. To have raced them on that windy Saturday afternoon in July would probably have resulted in a fatality, so the managers were wise in postponing it, as they did. There is a well-defined rumor going around that hereafter all racing yachts must be classed by an American classification society and their seaworthiness assured under all conditions of weather. Who could imagine the original schooner yacht *America* failing to go out and sail a race because the wind happened to be fresh?

Syndicate A of the new Underwriters' Association to take over the insurance on American ships and cargoes is being formed and will soon be functioning. This syndicate will be devoted entirely to survey work and its activities will be very much similar to those of the London Salvage Association. Mr. Charles R. Page, a gentleman who has been connected with marine insurance companies for many years, and recently a member of the Shipping Board, will be the director of the new syndicate and will shortly take up his headquarters on Beaver street in New York City.

July Shipbuilding Returns.—The Bureau of Navigation, Department of Commerce, reports 171 sailing, steam, gas and unrigged vessels of 214,840 gross tons built in the United States and officially numbered during the month of July. Of this amount 24 vessels of 147,699 gross tons were built for the United States Shipping Board.

Welding a Lighthouse Foundation

During the arctic winter of 1917-1918, when zero weather paid frequent visits even to the Carolinas, a most unusual accident happened to Wade Point lighthouse, which is situated one mile from shore in the northeasterly part of Albemarle Sound, N. C.

A large ice-flow which had formed in Albemarle Sound became detached by a terrific gale, and was driven with great force against the five cast iron columns which support the superstructure of the lighthouse in a depth of 9 feet of water. So great was the pressure of the ice after it had piled up on one side of the structure that the columns were bent over in a northwesterly direction and broken through, the columns below the breaks standing at an angle of about 20 degrees with the vertical.

When the question of making a permanent repair was under discussion by the Lighthouse Service, it was decided to weld the columns by means of the thermit process instead of putting in new foundations, the cost of which would be excessive.

Wade Point Lighthouse With Temporary Wooden Pile Construction and Three Welds Completed (Two Front Corners and Left Rear Corner)

Owing to the isolated situation of the lighthouse all welding materials were transported from Norfolk, Va., by a small steamer, which was moored alongside the lighthouse during the welding operation and served as quarters for the men.

It was first necessary to jack up the superstructure in order to remove the weight from each column successively as it was being welded, also to control the allowance for the contraction of the weld.

In spite of the intense heat of the thermit reaction no injury occurred to the lighthouse.

Each weld was allowed ample time to cool, after which the mold box surrounding the weld was dismantled and the thermit steel pouring and heating gates and risers cut off.

Each of the welds, all of which proved entirely satisfactory, required from 125 to 175 pounds of thermit, according to the size of the opening cut out.

The actual time consumed in making the five welds was a little less than three weeks.

Marine Engineering

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WE GUARANTEE that of this issue 9,150 copies were printed; that of these 9,150 copies 7,799 were mailed to regular paid subscribers, 442 were provided for counter and news company sales, 401 were mailed to advertisers, 79 were mailed to employees and correspondents, and 429 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 89,650—an average of 9,961 copies a month.

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The Shipbuilding Situation

ALTHOUGH contracts for new ships have not been coming in as fast as we would like to see them during the last few months, the fact still remains that the yards, as a whole, now have a total tonnage on their books for private account that is very much greater than it was a year ago. On July 1, 1919, there were under contract for private owners only 16 ships of 83,910 gross tons, while according to a report of the Atlantic Coast Shipbuilders' Association dated July 31, 1920, the American shipyards had a total of 307 steel vessels of 1,454,102 gross tons building or under contract for private owners. Transferring the gross tonnage into approximate deadweight tonnage, and multiplying by $200, a price which is less than the Shipping Board has been asking for its best type of freighters, we now have ships building to the value of $436,230,600.

In addition to this, there are the vessels and warships building for the Shipping Board and Navy Department, an amount sufficient to bring the gross tonnage now building up to about 3,000,000. Considering that we are in a period of transition from the most stupendous shipbuilding activity ever attempted anywhere, when men from all walks of life were helping to build ships, to a permanent peace basis, the outlook for our shipbuilding industry should not be pessimistic. If we had had the amount of work now on the books in our shipyards at any time before the war we would have then considered it a shipbuilding boom.

Having taken stock of the amount of our present work, the question remains, "What are the prospects for future contracts?" We know that there is an insistent demand for tankers. The New York Shipbuilding Company has recently sold two stock tankers at $225 a deadweight ton, and it has been announced that this company will lay the keels for two or more tankers for its own account this fall. The Sun Shipbuilding Company and the Merchant Shipbuilding Corporation have between them thirty-seven vessels to build, most of which are tankers. Shipbuilders report that inquiries for tanker tonnage are increasing, and we know that some steamship lines are figuring on having their own tankers to insure a reliable supply of oil for their own vessels.

In regard to passenger vessels, we know that the International Mercantile Marine Company, the Munson Line, the Red D Line and others have been working on plans for this type of vessel for their respective lines. Mr. Edward N. Hurley, in his recent book entitled "The New Merchant Marine," has very clearly set forth the necessity of providing for adequate passenger service in American-built vessels. We know that established steamship lines have been very prosperous and are at present amply able to finance the construction or purchase of such ships as they need.

Another type of vessel that will take no small place in future construction is the motorship. The best proof of this is the fact that a large number of our shipyards and manufacturers of marine machinery have expended vast sums on the construction and development of the marine type of Diesel engine.

In conclusion, it should be noted that the object of the Merchant Marine Act is to provide for the development of shipping and shipbuilding and that both Republicans and Democrats are in accord on this subject. Is it reasonable to suppose that the operating companies are not going to save their excess profits taxes by investing them in the construction of new ships as provided for in the Jones Bill, or that no one will take advantage of the construction loan of $125,000,000 which this bill provides for the construction of the best type of vessels?

Safety of Ships at Sea

THE significant feature of the recent summer meetings of the British Institution of Naval Architects at Liverpool is that the strictly ship papers and the discussions thereon were devoted almost entirely to the problems of subdivision and safety of merchant vessels at sea. In connection with this it is interesting to note that at the last meeting of the American Society of Naval Architects and Marine Engineers, which was held in New York last November, Professor William Hovgaard, under whose direction the calculations of stability involved in the conversion of the German liners into troopships were made, presented a paper entitled *Buoyancy and Stability of Troop Transports*. Aside from the fact that transports usually carry more persons than passenger liners of the same size and the vital importance of the safety of troops in time of war, the principles outlined in this paper are equally applicable to merchant vessels.

The three great marine disasters, namely, the sinking of the *Titanic*, of the *Lusitania*, and of the *Empress of Ireland*, where in each case over a thousand lives were lost, have evidently made a profound impression on the minds of the British naval architects. The shipowners, however, who are the people most concerned in this question from the standpoint of first cost and operation, which will be vital factors in the forthcoming struggle for international shipping supremacy, did not take the opportunity to present their side of the case. It is certain that a satisfactory solution of such problems as the subdivision of vessels into watertight compartments by transverse bulkheads, the length of steps or recesses in bulkheads, proper openings in longitudinal bulkheads to prevent serious listing when bilging occurs, watertight doors, sidelights below the bulkhead deck, etc., cannot safely be left to indivdual concerns who are apt to rely too strongly on the navigating ability of their captains.

An International Convention for the Safety of Life at Sea, composed of representatives of the principal maritime countries, was held in London in 1914 and subsequent recommendations were made by the British Board of Trade, but, owing to the war, no action has been taken by any country except England, which has recently decided to enforce rules that are similar to those recommended by the Convention. England deserves credit for showing us the way in this matter, but she is thereby placing a handicap on her shipping in the way of cost and operation. We in the United States have safeguarded our railroads and industries with all kinds of safety rules and devices, and it is to be hoped that we will follow suit in this matter by enacting laws that will make our passenger vessels as safe as it is possible to do. In the long run this will be found the best policy, as the public will travel on those vessels in which they have the most confidence, be they American or British.

Those who have constructed curves of floodable length for the proper spacing of watertight bulkheads will be interested in the simplified method proposed by Mr. George Webster in his article entitled *Subdivision of Passenger Vessels,* which appears on page 726 of this issue. This method eliminates a great deal of unnecessary work and allows the dimensions of a proposed vessel to be determined with greater dispatch. The substitution of depth for draft in the freeboard and sheer ratios does not appear to make a material change in the standard curves, but it does simplify the work. A simple and satisfactory method of calculating the permeability is also given which is a great improvement on the cumbersome alternative given in the Board of Trade rules. However, the greatest innovation presented in this article is a special slide rule which seems to be adaptable to easy manipulation. The question of the accuracy of this rule will, of course, be questioned, but more elaborate calculations than here required are made on slide rules and are found to be sufficient for the purpose.

Shipping men, as a rule, are slow to accept changes or new equipment, and rightly so, because a storm at sea is not an ideal place to try experiments, but this argument does not apply to the construction of a vessel on such lines that with careful navigation the loss of passengers, cargo or ship will be reduced to a minimum.

Cooperation

THE principle of cooperation between the individual institutions of an industry, based on the fact that only as the permanent prosperity and popularity of that industry is attained will the individual concern be assured of continued success is a truth of which most progressive business men are convinced. It is only natural to feel anything but sorry at a breakdown or failure in the product of a competitor, in spite of the fact that the industry itself suffers in the confidence of the public. Competition, which is known to be a stimulus to development, should be conducted on a live and let live basis along the lines of fair play, and criticism, if offered, should be constructive rather than destructive.

Nowhere is the interchange of ideas and mutual effort for the common good more necessary than in the shipping and shipbuilding field, because these industries have been so greatly extended during the last few years that we lack a sufficiently experienced personnel to compete efficiently with the leading shipping countries on a peacetime basis. Our policies will have to be worked out for the general good if we are to succeed, and it is for such purposes that the American Steamship Owners' Association and the Atlantic Coast Shipbuilders' Association are working.

Our merchant marine was built for a patriotic purpose and there is still a tendency to use patriotic reasons for its development, losing sight of the possibilities that shipping offers in the way of financial return. In the olden days the American boys took naturally to shipping because it was profitable, most of them expecting to become an East Indian merchantman, and the best way to secure the cooperation of the brains and capital of this country today is for shipbuilders and ship operators to work together in a large way and prove that the opportunities in this line are as great as in any other. The facts that the Atlantic Gulf and West Indies Company earned over 30 percent on its common stock during the last year on the one hand, and the incorporation of many new steamship lines on the other, may be cited as indications upon which to base an optimistic outlook.

Teamwork between the shipowners and shipbuilders, having the object of securing the best and most economical vessels for specific routes, will be found mutually beneficial. Our shipbuilding programme is by no means complete, as we lack not only tankers and passenger vessels but also special types of freighters. The cargo vessels constructed during the war are not the best type of ships for certain services, and the established steamship lines will undoubtedly give careful consideration to the operating expenses and earning power of specially designed ships, unless the cost of the Shipping Board vessels is sufficiently low to warrant their purchase.

The success of shipping and shipbuilding depends to a large extent on each other, but the prosperity of the nation, with its greatly expanded industries, is dependent on transportation facilities. Shipping is a subject on which we all ought to get together and boost as a means of safeguarding our future economic independence.

LETTERS TO THE EDITOR

Method of Estimating Steel Hull Weights

I have read with considerable interest the *Method of Estimating Steel Hull Weights* published in the August, 1920, issue of Marine Engineering.

While I personally use the *Cubic Number Method* which the author describes towards the end of the article, I have noted a number of interesting points in connection with same which he does not mention, but which would undoubtedly affect his method, and which might possibly save some of the newer men in the shipbuilding game from making errors in the estimating of net steel weights.

As the displacement ratio of the vessel decreases, so does the cubic coefficient, at the rate of about 0.002 for a change of 0.01 in the displacement ratio; similarly, the cubic coefficient decreases about 0.001 for a decrease of 0.1 in the ratio of length to depth. The cubic coefficient is about constant for similar vessels over 400 feet in length, but below 400 feet in length it increases in a gradual curve to about 0.05 greater for a vessel 200 feet in length than the coefficient of a similar 400-foot vessel. The reduction of the coefficient which he gives for longitudinally framed vessels, compared with that of transversely framed vessels, seems rather low, as longitudinally framed vessels have almost invariably at least 6 percent less net steel than a duplicate vessel built on the transverse system, and frequently run as high as 10 percent less.

The corrections which I have given above to the coefficient due to displacement ratio, length to depth ratio, and length, are fairly accurate for small changes in these factors; but the coefficient correction curves are not quite straight lines and should accordingly not be used for extreme differences. The coefficients which he quotes (0.40 to 0.44 for transverse vessels) are, in my experience, hardly broad enough to cover the usual variations of vessels, as I personally know of many cases where this coefficient is as low as 0.03 for sea-going full scantling ships.

While I am of the opinion that the cubic number method can be used to give quite as accurate results (with a little care in comparing the new ship with the one on which the cubic number is based) as the method the writer of the article proposes, may I not suggest that he permit you to publish the numerous curves he proposes, so as to save the newcomers in the shipbuilding field the considerable amount of work necessary to prepare such a set of curves. They would also serve as an interesting check for those of us who care to continue using the *Cubic Number* method.

Vancouver, Wash. S. A. Vincent, Naval Architect,
G. M. Standifer Construction Corporation.

Revision of Weights for Sections of Minimum Web Thickness of American Standard Beams and Channels

In 1896, The Association of American Steel Manufacturers adopted a list of standard profiles of structural steel sections which are known as American Standard Structural Sections. In 1911, the association also adopted standard methods of computation for published weights and areas. The weights that were published for the minimum thicknesses of beams and channels did not correspond exactly to the published areas and it has long been known that it is impracticable to furnish these sections true to both the published weights and dimensions.

To correct this situation, the association has just adopted as American standards the weights per foot shown in the third column of the table below for the sections of *minimum* web thicknesses which do correspond to the published dimensions.

		Weight, Pounds per Foot	
Section	Depth, Inches	Present Weight	New Weight
Beams	3	5.5	5.7
	4	7.5	7.7
	5	9.75	10.0
	6	12.25	12.5
	7	15.0	15.3
	8	18.0	18.4
	9	21.0	21.8
	10	25.0	25.4
	12	31.5	31.8
	12	40.0	40.8
	15	42.0	42.9
	15	60.0	60.8
	15	80.0	81.3
	18	55.0	54.7
	20	65.0	65.4
	20	80.0	81.4
	24	80.0	79.9
	24	105.0	105.9
Channels	3	4.0	4.1
	4	5.25	5.4
	5	6.5	6.7
	6	8.0	8.2
	7	9.75	9.8
	8	11.25	11.5
	9	13.25	13.4
	10	15.0	15.3
	12	20.5	20.7
	15	33.0	33.9

There is to be no change in the profiles and properties of sections of minimum web thickness nor in the weights and properties of the intermediate and maximum sections of American standard beams and channels.

The new weights are to be put into effect September 1 by all of the companies rolling these sections.

Pittsburgh, Pa. J. O. Leech, Secretary,
The Association of American Steel Manufacturers.

NEW BOOKS

Ships' Boats

REVIEWED BY C. H. PEABODY, DR. ENG.

Ships' Boats: Their Qualities, Construction, Equipment and Launching Appliances. By Ernest W. Blocksidge, M. I. N. A. Size, 5½ by 8½ inches. Pages, 500. Illustrations, 256. New York, 1920: Longmans, Green & Company. Price, $9.

The author of this book is ship surveyor to Lloyd's Register of Shipping, and formerly ship surveyor to the British Board of Trade, and has had the opportunity and taken occasion to make himself thoroughly familiar with the design, construction and use of ships' boats.

Mr. Blocksidge presents for the first time a complete and authoritative work on a very important branch of naval construction; the importance of life saving at sea is now recognized not only by the profession but by the public in consequence of the disasters to the *Titanic* and to the *Lusitania*, and has found expression in the report of the International Convention on Life-Saving at Sea; and this book is prepared with the findings of the Convention in view. His work is prepared for shipbuilders and shipowners of Great Britain, but is applicable with some allowance to the needs of the merchant marine of the United States.

The author begins with the history of requirements for lifeboats. Previous to 1890 the requirements for boats were based on the registered tonnage of the ship and had no relation to the number of persons aboard. In that year the rules for life-saving appliances adopted the principle that on all cargo vessels the boat accommodation should be sufficient for all on board. These rules substituted gross for registered tonnage, which increased the boat accommodations by fifty percent. Subsequent regulations somewhat improved matters, but at the loss of the *Titanic* the boat equipment was sufficient for only women and children and a few of the men. Hasty legislation in both Great Britain and the United States required the provision for all persons on board, both passengers and crew. For ships in commission it was impossible to make real adequate provision, and certain temporary devices were allowed for nominal compliance with the law. An ill effect of such hasty legislation is evident in the description of certain classes of boats described in this book.

Part II of the book gives the rules for the British merchant shipping as affecting boat accommodation and installation of davits, a classification of boats, and a discussion of form, stability, strength and capacity. We are naturally most interested in ships in foreign trade. For such passenger ships it is required that each ship shall carry boats sufficient to accommodate all persons on board, either the total number or the certified number, whichever is the larger. The number of davits is made to depend on the length of the ship. The requirements of number of davits and of cubic capacity of boats are given in a table advancing in steps from 100 feet to 1,030 feet. Thus a ship 100 feet long must have two davits, two boats and 980 cubic feet capacity in those boats; a ship 995 feet long must have 30 davits, 20 boats and 48,750 cubic feet capacity. Small ships have no difficulty in meeting requirements, but the difficulty increases with the length of the ship because the possible passenger accommodation increases in some sort of relation to the displacement, and that increases with the cube of the length. A certain table of particulars of boats gives for a 30-foot boat the capacity 607 cubic feet and assigns 60 persons to such a boat. Applying this as a unit to a ship 995 feet long there would be required 80 lifeboats. Thirty of these boats can be under davits, leaving 50 to be otherwise provided. The rules allow some or all of the boats not under davits to be collapsible boats; the Board of Trade is given large discretion and may allow the use of life rafts.

Seven classes of boats are described; four classes are real boats, i. e., (1) open boats with internal buoyancy, (2) open boats with internal and external buoyancy, (3) open boats without special provision for buoyancy, and (4) pontoon boats with fixed bulwarks. Internal buoyancy is provided by cans of copper or yellow metal, stowed under thwarts and side seats. External buoyancy is given by a band of solid cork outside the boat. The object of buoyancy is to give a reserve of buoyancy when the boat is flooded. The plain open boat has certain advantages from its lightness and handiness; it is supplied only to cargo ships having accommodations for all the crew on each side of the ship.

These three classes of open boats and their properties are well known by seamen. Properly constructed they are able boats and can make long voyages. A certain master seaman to the knowledge of the writer made a voyage of 1,200 miles in a ship's boat to find help for the crew of a ship wrecked in the Pacific Ocean.

Now we come to the question of the use of pontoon boats, which have a lower body or pontoon decked once above the waterline. To keep waves off the pontoon and to protect the passengers, there are bulwarks above the pontoon. If given sufficient strength, the bulwarks may serve these purposes, but they are not an integral part of the boat; in some types of boats they can be folded down.

The lower body or pontoon supplies the buoyancy, being closed and watertight; more buoyancy can be provided, and so more passengers may be assigned. Advocates of such boats claim correctly that the buoyancy of the pontoon ensures the life of the boat; unfortunately, the pontoon introduces certain characteristics that are not advantageous for the safety of passengers. This condition comes from the fact that passengers and equipment must be carried above the deck with a higher center of gravity; and, further, free water that may break over the bulwarks is more dangerous than it would be in the bottom of an open boat.

Mention has been made of a pontoon boat with fixed bulwarks; it is considered to be a good boat with ample stability when free from water, and giving fair protection to the passengers. It is said to be rarely supplied to passenger boats because it is at least as troublesome to carry as an open boat. The comparison of open and pontoon boats is brought out in the report of the Committee on Boats and Davits. Intact, both boats can carry full load and have sufficient stability; when partly swamped, the open boat with buoyancy cans has a fair stability; the pontoon boat has none, and is liable to capsize unless it has good relief valves to clear the water inside of bulwarks. When full of water, the open boat has very little stability; the pontoon boat has no stability until some of the water is spilled over the gunwale. There is great danger that the passengers will be spilled at the same time. The boat free from water and passengers may right itself.

In an attempt to meet the requirements that steamers shall carry boats enough for all persons, passengers and crew, boats with collapsible bulwarks have been introduced. With the bulwark down they can be stowed in tiers and save deck room. Three types are described by the author: (1) an open boat with buoyancy cans for buoyancy, (2) a pontoon boat with flush deck, and (3) a pontoon with a so-called well deck.

The open boat with the bulwarks intact is nearly as good when tested in quiet water as the regular open boat with inside buoyancy. The pontoon boats are much like the pontoon boat already described. The bulwarks amidships are made of wood, and when erect are held in place by the thwarts. At the bow and stern the bulwarks are made of painted canvas. The author shows such a boat carrying 54 persons counted as well as may be from the photograph, some seated, some standing. They do not appear to be uncomfortable with the boat as shown in a dead calm. The comparison with a standard lifeboat, which is a real little ship, is certainly not to the advantage of the substitute.

Attempts have been made to improve the collapsible boat by making the bulwarks of wood all the way round. Such boats are doubtless better, but they are not good. To the writer, a fisherman's dory looks better, and it stows closer.

The author shows a design of nested boats by Captain P. D. Murray. They are of three sizes, the smaller ones being stowed inside in succession. The larger boats have hinged thwarts and there are other devices to facilitate stowing. They appear to be real boats, though probably not so good as the standard.

Some attempt has been made to provide ships with one or more motor lifeboats usually provided with a cabin. If it were possible to provide enough motor boats and to handle them when needed, a great advantage would be gained. Even a few motor boats to guide, assist or tow rowing boats would be advantageous.

The author gives an excellent statement of various kinds of timber for boats, how timber should be cured and worked. He also goes into details of construction with drawings and instructions for inspection. There are over a hundred pages of such matter on rowing boats and considerable on power boats. He vouches for boats built of mahogany that have lasted more than twenty years. He deals also with metal boats, how they should be constructed and inspected in service; he reflects the prejudice against metal boats found among seamen. To a landsman it looks as though a well made and guarded metal boat should last forever, though, of course, galvanized iron as used for that purpose is known to be untrustworthy.

It is not sufficient to have lifeboats on a ship; there must be adequate provision for launching them full of passengers in an emergency. Boats carried under davits are ready for use. There are, of course, the chances of difficulty in lowering and disengaging when waterborne. Various devices are shown for these purposes; some are ingenious and meritorious, but it is not certain that they are better than accepted forms in the hands of trained men. However, trained men in sufficient number for a large passenger ship are difficult to provide.

When boats are too numerous to be carried under davits, some method of handling must be provided. There are a number of patent davits that can launch boat after boat. We can scarcely complain that time is needed for such service, especially when they are worked by hand. A real difficulty is that all are more or less complicated and require a trained crew for operation. On some large passenger ships the problem is attacked boldly by providing power gear for handling the boats and training crews to man the gear.

In an appendix the author deals briefly with life rafts and various buoyant apparatus.

The Sumner Line

REVIEWED BY C. H. PEABODY, DR. ENG.

THE SUMNER LINE OR LINE OF POSITION AS AN AID TO NAVIGATION. By George C. Comstock. Size, 4 by 6 inches. Pages, 70. Illustrations, 6. Folding plates, 3. New York, 1919: John Wiley & Sons, Inc. Price, $1.25.

If the navigator at his noon observation finds the sun directly overhead, he can find the location of his ship with ease and certainty, because the Nautical Almanac or the (Ephemim) provides ready determination of the location of the sun for any given time. Suppose that instead of having the sun directly overhead, the observation gives an altitude above the horizon as eighty-nine degrees, that is, the sun is one degree from the zenith. The navigator, as before, finds the sun's location and he knows that his ship is sixty sea miles from that position. If he takes the sun's location as a center and draws a circle with a radius of sixty miles, he knows that his ship is somewhere on that circle. If the altitude is some other angle, say eighty degrees, then the same conditions hold and the ship is six hundred miles from the same location.

In order to use this information—that is, in order to draw the Sumner line of position, the navigator must have some elementary knowledge of practical astronomy; but the author asserts that the method is easy and simple in practice, especially with the aid of certain tables issued by the Navy Department. The author presents the actual operations of this method with illustrative examples, clearly and succinctly. For those who desire to know the rational development of the method, the author gives the proper demonstrations separately.

This method can as readily be used for observation on stars; in fact, it is especially adapted to that purpose, since it should be easy to select a star with convenient altitudes, and a star does not wander around the heavens as the sun does.

Evening Courses in Ship Design and Marine Engineering at Brooklyn Polytechnic Institute

SEVERAL special evening courses which will be of interest to men connected with the shipbuilding and shipping industries have been arranged for the coming winter at the Polytechnic Institute, Brooklyn, N. Y. These courses cover ship drawing and design, yacht design and marine engineering. They will begin early in October, and registration may be made any time between September 15 and October 1, by addressing the Director of the Evening Department, Polytechnic Institute, 99 Livingston street, Brooklyn, N. Y.

The course in ship drawing and design will consist of a series of lectures and exercises in calculations and drawing, illustrative of the work done in the hull design department of a shipyard. This course is given by Mr. F. B. Webster, editor of MARINE ENGINEERING and the SHIPBUILDING CYCLOPEDIA. Mr. Webster is a graduate of the Department of Naval Architecture and Marine Engineering of the Massachusetts Institute of Technology, and has had many years of practical experience in hull and engine work as well as designing experience in both lines in various shipyards. He was formerly engaged in research work in the Bureau of Construction and Repair, Navy Department, Washington, D. C., and during the war was naval architect for the concrete ship section of the Emergency Fleet Corporation.

The course in yacht design will deal with the design of the hull of a vessel, the drafting and fairing of lines, and the calculations of the various properties of the floating body from the lines. While a small yacht hull is used in the course, the principles of theoretical naval architecture there exemplified apply to a ship of any size, and the instruction will be of value to all those engaged in any field of marine work.

Two courses are offered in marine engineering. The object of the first is to furnish special training in marine engineering to men already possessing technical knowledge in steam and mechanical engineering. This course will cover engines, boilers, auxiliaries and piping. The second course is planned for men now holding non-technical positions in shipbuilding, ship repair, and marine transportation companies, and for others without special training in engineering lines who wish to gain a general knowledge of marine engineering as an aid to them in their work.

For information regarding the requirements for applicants for these courses and the hours and fees, requests should be sent to the Director of the Evening Department of the Institute.

The course starts with lectures and study assignments on the structural arrangements of a steel ship, and while these are being carried on, practice is also given in the drawing and tracing of typical details of ship construction. This is followed by a study of the rules of the classification societies, and the assignment of a special problem to each student on the design of a particular type and size of ship. Finally the method of basic design of a vessel is explained.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Standing Rigging for Signal Masts

Q. (1054).—Kindly inform me how the standing rigging is determined on ships with unusually high rigging, as scout cruisers, destroyers, etc., without cargo booms. T. R. P.

A. (1054).—A mast is subjected to complex forces which make it difficult to determine the stress coming upon the rigging. However, we may consider that the mast is not fixed at the deck, but acts in the nature of a column free at the ends and of length equal to the distance from the deck to the point of attachment of the lower rigging. If, then, the effect of the upper rigging is neglected, the forces and their moments about the foot of the mast can be approximated. The principal forces will be as follows:

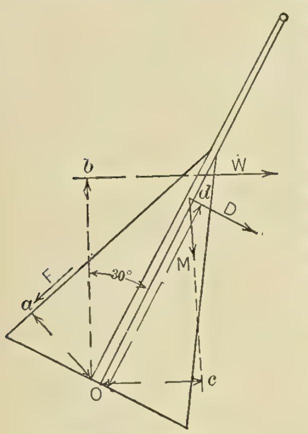

Diagram of Forces

Fore and aft forces to be taken care of by the stays.
- Dynamic force due to the vessel's pitching.
- Wind force due to a head wind of high velocity.
- Static force due to the mast's weight at the maximum angle of pitch.

Athwartship forces provided for by the shrouds.
- Dynamic force due to the vessel's rolling.
- Wind force due to wind at high velocity.
- Static force due to weight of mast at extreme angle of roll.

The above forces, with the exception of the mast's weight, will have to be approximated by assuming an angle of pitch and time of pitching, also the same with rolling and, furthermore, a maximum wind velocity.

The dynamic force of pitching would be:

$$F = \frac{W \pi^2 l \theta}{g t^2},$$

in which t is the time of a single pitch, l is the distance of the center of gravity of the mast from the axis of pitch, and θ is the maximum angle of pitch. The same formula will also serve for rolling. A formula giving the wind resistance of a cylinder can be used to find the wind force on the mast.

The above forces will produce a moment about the foot of the mast which the resisting moment of the rigging must equal and from that the necessary force in the rigging may be computed. The figure shows the athwartship forces and their moment arms with the vessel at 30 degrees roll, where

oa = moment arm of force in shrouds (F).
ob = moment arm of wind force (W).
oc = moment arm of mast weight (M).
od = moment arm of dynamic force (D).

An example has been worked out by this method in "Strength of Ships" (Longmans-Green) by A. J. Murray. Another distinct calculation is made sometimes for the stress in the shrouds, if the vessel is on her beam ends (inclined 90 degrees).

Size of Lifeboat Davit

Q. (1055).—Please indicate the method of finding the diameter of a solid wrought steel davit for a lifeboat of the following dimensions: 24 feet by 7 feet 9 inches by 3 feet 4 inches. I note that the United States Steamboat Inspection Service does not directly specify the diameter, but makes the requirement that the davit must be strong enough to lower the boat when the vessel has a list of 15 degrees. What would be the stress in the davit when vessel is upright, also when at a 15-degree list?

A. (1055).—If we take the height and radius of the davit as given in the figure, the diameter of davit in way of its upper bearing can readily be obtained from either the American Bureau or Lloyds Rules.

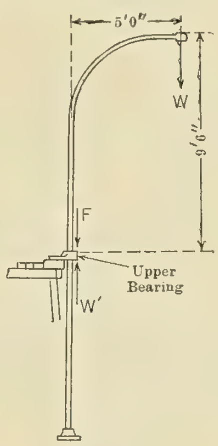

Fig. 1

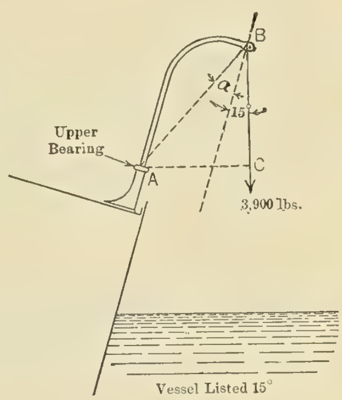

Fig. 2

$$d = \sqrt[3]{\frac{L \times B \times D\,(H + 4S)}{C}} \text{ inches (Lloyds),}$$

where L, B and D are the length, breadth and depth of the boat, respectively, in feet.

H = height of davit, in feet, above its upper bearing.
S = radius or outreach of davit in feet.

The value of C depends upon whether the davit is to be strong enough to lower the boat and several men or the boat and its entire complement. It also depends upon what material the davit is made of. If we consider that in this case the davit is forged of wrought steel of about 65,000 pounds per square inch tensile strength and is designed to lower the boat and full complement, a constant $C = 99$ is required, so that we have:

$$d = \sqrt[3]{\frac{24.0 \times 7.75 \times 3.33\,(9.5 + 4 \times 5.0)}{99}} = 5.70 \text{ inches, or about } 5\tfrac{3}{4} \text{ inches.}$$

In order to obtain the stress we may approximate the weight of boat equipment and complement as 7,800 pounds. Thus a load of 3,900 pounds, with the vessel upright, can be resolved into a downward force, $F = W$, acting at the center of the davit section in way of the bearing and a couple whose moment arm is 5 feet. This force and couple will then produce:

Bending Moment = 3,900 × 5 = 19,500 foot-pounds.
Direct Load = 3,900 pounds.

The tensile and compressive stress due to the bending moment will equal:

$$f_b = \frac{My}{I} = \frac{19{,}500 \times 12 \times 2.88}{53.6} = 12{,}580 \text{ pounds per square inch.}$$

$$I = \frac{\pi d^4}{64} = \frac{3.142 \times 1{,}093}{64} = 53.6.$$

The compressive stress due to the direct force will be:

$$f = \frac{P}{A} = \frac{3{,}900}{25.97} = 150 \text{ pounds per square inch.}$$

Hence the resultant of these stresses will be:

Compression = 12,580 + 150 = 12,730 pounds per square inch.
Tension = 12,580 — 150 = 12,430 pounds per square inch.

To find the increased stress due to a 15-degree list (see Fig. 2), it will be necessary to find moment arm AC, which can be obtained by the following steps:

$$AB = \sqrt{5.0^2 + 9.5^2} = 10.75 \text{ feet.}$$

$$\sin \alpha = \frac{5}{10.75} = .465.$$

$$\alpha = 27^\circ\ 43'.$$

$$\text{Angle } ABC = 27^\circ\ 43' + 15^\circ\ 0' = 42^\circ\ 43'.$$

$$AC = 10.75 \times \sin 42^\circ\ 43' = 10.75 \times .6784 = 7.29 \text{ feet.}$$

If a moment arm of 7.29 feet is replaced for that of 5 feet in the preceding work, we will obtain:

Bending Moment = 7.29 × 3,900 = 28,500 foot-pounds.

$$f_b = \frac{28{,}500 \times 12 \times 2.88}{53.6} = 18{,}370 \text{ pounds per square inch.}$$

Hence the stress due to bending is nearly 50 percent greater with vessel listed than when upright. With the vessel listed there would furthermore be a stress of shearing on the davit cross-section, besides that of tension and compression, which we have not mentioned.

Repairs at Dry-Docking

Q. (1056).—Please list the repairs ordinarily undertaken while a vessel is in dry dock, and also give the length of time between dockings.

A. (1056).—The length of time between dry-dockings depends upon many factors, such as the port repair facilities, time available, the practice of the operating company, etc. Some companies make it a custom to dry dock a vessel every six months, others at a much longer interval. The United States Shipping Board has tried to average about eight months between dockings. It is wise to dry dock a new vessel within six months of launching.

Besides the managing company's shore representative, a surveyor from the registration society, and possibly an inspector from the United States Steamboat Inspection Service, who have been notified in advance of the docking, will make an inspection of the vessel and require or suggest various repairs, some of which are noted here. If the shell plating is indented perceptibly, these plates should be located, and if not faired at this time a record should be kept of same so as to place the responsibility.

If it be a new vessel it will be advisable to remove the propeller, fair water cone and harden up the propeller nuts (which may take up a quarter of a turn in the case of a new wheel). If time permits, find the pitch of the propeller, doing this for all blades. Examine and harden up blade nuts of separable blade propeller, if necessary. Measure the amount of clearance in the stern bearing (i. e., the amount the shaft is down). The lignum vitae is bored for a clearance of about 1/16 inch and the classification societies require that this bearing be re-wooded when this clearance as shown by a tapered wooden wedge has increased to about 5/16 inch.

Tail Shaft and Rudder Gudgeon Bearings

If the tail shaft has two separate bronze liners, or one at the stern bearing near the propeller and one in way of the stuffing box at the aft peak bulkhead, the classification societies will require that the shaft be drawn clear of the stern tube for survey every two years. This consists in tapping the liners lightly to see whether they are loose, also to examine the shaft between the liners for cracks or undue corrosion. The fit of the propeller on the tail shaft should also be examined. This must bear at the large end of the taper; the small end of the shaft's taper can be .005 inch smaller in diameter than the hole in the hub for a large propeller. The fit and bearing of the key should also be checked, as, if local, the tail shaft may crack; looseness will, of course, cause vibration. Some firms, with the separate liner type of tail shaft, red lead the shaft between liners and cover it with canvas and a layer of rope marline coated with red lead. If the bronze liners are continuous, i. e., in separate pieces but soldered to each other at the joints, the societies call for the tail shaft survey every three years.

Further repairs directly under the engineering department would be to examine and grind in, if necessary, all sea valves, clear their strainers and repack the tail shaft gland.

The rudder gudgeon pin or pintle bearings should be examined for proper bearing and clearance; when new, the latter may be about 3/32 inch on the diameter of the pin for a fair sized cargo vessel. The gudgeon pin bearings are either lignum-vitae or bronze, although of late soft steel has been used.

Riveting, Scraping and Painting

It is advisable where possible when docking to have all ballast tanks full, as any leaks will then readily show up. Any tanks that require cleaning or rivet driving may be drained, although with steam up they can be more quickly pumped out, and the writer would advise that steam be kept up, as the ship can be listed or trimmed, if desired, and is under control. All leaky rivets (and most war emergency ships have enough of these) will be calked, hardened up or re-driven as required by the classification society surveyor and the work when completed passed by him.

Before coming off the dry dock it is customary to wire-brush or scrape the shell plating and apply one coat of anti-corrosive, together with a coat of anti-fouling, below the light waterline and one of boot-topping above. If the time in dock permits, it is a good plan to run out all the anchor chain, wire-brush or scale it, and paint it with fish oil.

If the important repairs, condition of the hull, condition and clearance of tail shaft and rudder gudgeon bearings and any other important data are noted in the log books, much money will be saved in the operation of the vessel by avoiding the needless repetition of certain repairs, and a better report can be turned into the managing company.

PERSONAL MENTION

E. L. Whitney was recently elected president of the Kelly Drydock & Shipbuilding Company, of Mobile, Ala.

David C. Young, who until recently was general manager of the Hanlon Dry Dock and Shipbuilding Company, has been placed in charge of the Seattle office of the Martin-Gardner Survey Board for the inspection of Shipping Board tonnage.

Alfred H. Haag, formerly chief constructor for the United States Shipping Board Emergency Fleet Corporation, has opened offices at 406-408 Water Street, Baltimore, Md., as a consulting naval architect and marine surveyor. Mr. Haag is considered to be one of our best authorities on ships' rigging and cargo handling gear, a subject of very great importance to the economical operation of the merchant marine.


Alfred H. Haag

The Atlantic, Gulf and Pacific Steamship Company, which has a fleet of ten vessels aggregating about 90,000 deadweight tons, has retained Mr. Haag as naval architect for their line. The care of these vessels, which range from 7,400 to 11,400 tons deadweight capacity, is quite an assignment in itself and we feel that Mr. Haag's success in his new location is assured.

Slightly more than twenty years ago Mr. Haag began work, at the age of fifteen years, in the offices of Cary Smith & Barbey (later Cary Smith & Ferris), naval architects, New York, remaining with them five years. The following five years he served in the drawing rooms of the following well-known naval architects: H. C. Wintringham, Henry J. Gielow, and Tams, Lemoine & Crane. While with the latter firm he received an offer from the War Department in Washington in the ship design branch of the Quartermaster General's office, after which he accepted an appointment with the Navy Department, first serving in the drawing room of the new design section and later in the scientific department. While with the Navy Department he received an offer from the Newport News Shipbuilding & Dry Dock Company, in the engineering section, which he accepted, remaining with them eight years. He left this company just prior to this country's entering the war to go into business for himself in Philadelphia. He had hardly started his new business when he received a call for his services from the United States Shipping Board, which was then organizing, and was appointed to the position of chief draftsman at the home office of the United States Shipping Board, Emergency Fleet Corporation. Later he was promoted to the position of assistant chief constructor and finally to the position of chief constructor.

Mr. Haag is a member of the American Society of Marine Draftsmen, having held the office of national president for the past two years. He is a member of the Society of Naval Architects and Marine Engineers and consulting editor of the *Shipbuilding Cyclopedia.*

William H. Todd, president of the Todd Shipyards Corporation, New York, in recognition of his valuable service during the war, was awarded the degree of Doctor of Laws by the Most Reverend Patrick J. Hayes, archbishop of the diocese of New York, at the commencement exercises of Manhattan College held in Carnegie Hall, New York City, June 16. Brother Thomas, dean of the college, in announcing the award, said:


William H. Todd

"The honorary degree of Doctor of Laws is conferred on a leading citizen of Brooklyn; a man of constructive genius, who, starting life as a boy-mechanic, in his early twenties stood first on the civil service list of the Navy Yard as a master shipbuilder. Later in private life, beginning as foreman, he rose in a decade to the presidency and then to the ownership of the largest ship repair yard in the world.

"He is today recognized as the premier shipbuilder in the United States. A leader of men, employing upwards of twenty thousand—every one of whom knows and loves him—he is described by one of the great captains of industry (Charles H. Schwab) as 'a human dynamo; a man among men, who does things, and whose life is a record of achievements.' He is a philanthropist and a patriot."

George Gillis Sharp, consulting naval architect and marine surveyor, has opened offices at the Hudson Terminal building, 30 Church street, New York. Mr. Sharp, the late chief surveyor of the American Bureau of Shipping, is a graduate of Glasgow Technical College, where many of our American naval constructors have received their post-graduate courses. His practical training was acquired at the D. & W. Henderson Company, the oldest of the famous Clyde shipbuilding companies. Mr. Sharp came to America to take the position of chief draftsman with the Eastern Shipbuilding Company, which built the Great Northern liners *Minnesota* and *Dakota*, a noteworthy event for his début into American shipbuilding. After the completion of these marine giants, Mr. Sharp entered the employ of the Harlan & Hollingsworth plant as chief draftsman, and from there went to the Pacific Coast to take the position of chief draftsman in the Seattle Construction & Dry


George G. Sharp

Dock Company, Seattle, Wash., thus rounding out his American shipbuilding experience on both coasts.

In 1913, Mr. Sharp returned to his former position as chief draftsman of the Harlan & Hollingsworth Company, which was in itself an endorsement of his former work, and remained there until 1913, when he went with the American Bureau of Shipping as deputy chief surveyor. With the outbreak of the war, Mr. Sharp became chief surveyor of the bureau, and under his technical guidance the bureau expanded in leaps and bounds, until it reached the state it is in today, with offices in all the principal American ports and many foreign ports such as Hong Kong, Buenos Aires, Havana, etc. As chief surveyor of the American Bureau of Shipping, Mr. Sharp built up an organization that is world wide in its habitat and activities and international in its importance—an organization that during a war of unprecedented marine malevolence and destruction helped create out of a chaos of cross purposes and political trickery the second greatest mercantile marine sailing the seven seas today.

C. Steindorff has been elected vice-president and treasurer of the Brooks Steamship Company, New York, to succeed F. Bradley Cox, resigned.

Charles O. Lenz, consulting engineer, New York City, has been appointed one of the consulting engineers for the Foundation Company of New York City.

Frank Burke, assistant chief of the Bureau of Investigation of the Department of Justice, has been appointed assistant to Chairman Benson of the Shipping Board.

W. B. Keene, who has been district director of the Shipping Board in the Gulf district, has been appointed assistant director of operations in the general office at Washington.

Lester C. Neff, former district agent of the Shipping Board, Galveston, Tex., has resigned to become assistant general manager of the Export Steamship Company, Inc., Baltimore, Md. He is succeeded in the operating department of the Shipping Board by C. H. Marshall, whose offices will be at New Orleans.

Brigadier General Frank T. Hines recently resigned from the army to become general manager of the Baltic Steamship Company. During the war, General Hines made possible the rapid handling of men and supplies of the American Expeditionary Forces with the development of terminals, which he was able to do as head of the Transportation Service of the Quartermaster's Corps.

Harris Livermore, senior operating officer of Livermore, Dearborn & Company, Inc., and likewise president of the Shawmut Steamship Company, New York, will become president of the United American Lines, Inc. Henry Dearborn, son of the late George S. Dearborn, of the Hawaiian Steamship Company, now the senior vice-president of Livermore, Dearborn & Company, Inc., will become vice-president of the United American Lines, Inc.

Brigadier General William D. Connor will succeed Brigadier General F. T. Hines as chief of the Inland Waterways Division of the War Department. General Connor is particularly familiar with Mississippi River conditions. During the war he served as chief of staff, Headquarters Service and Supplies, under General Harbord in France. After General Pershing returned to the United States he became general in command of the American forces in France.

J. F. M. Stewart, Toronto, Can., director of the Halifax Shipyards, Ltd., Halifax, Nova Scotia, has been elected a director of the Dominion Steel Corporation of Toronto, Canada.

Romeo Morrissette, until recently connected with the National Shipbuilding Corporation, Three Rivers, Quebec, has entered private practice as a consulting engineer in that city.

R. A. Dean, assistant counsel for the Shipping Board, and Judge Goff, general counsel for the Emergency Fleet Corporation, have been elected trustees of the Emergency Fleet Corporation.

Captain M. S. Harloe, of the Division of Operations of the Shipping Board, is at the present time engaged in establishing Shipping Board agencies in the important centers of the Orient.

A. J. Frey, director of construction and repairs of the Emergency Fleet Corporation, has resigned to become manager of the Los Angeles Steamship Company. He was formerly connected with the old Pacific Mail Steamship Company.

Christian J. Beck, formerly manager of the freight traffic department of the Hamburg-American Line, and more recently general manager of the Kerr Steamship Company, has become the head of the executive personnel of the United American Lines, Inc.

John Quinn, district director of the Shipping Board at Boston, has succeeded W. B. Keene as director in the Gulf district, and P. H. Lacey, of the Operating Department, Washington, is to succeed Mr. Quinn as acting district director for the New England section.

Joseph Stull, Jr., formerly general superintendent of the Pusey & Jones Gloucester, Pa., yard, has been appointed assistant manager in charge of the ship construction division of the United States Shipping Board Emergency Fleet Corporation, with headquarters in Philadelphia.

Dudley W. Burchard, for the last two years district agent of the operating division of the Shipping Board at Puget Sound, has been appointed head of the newly created North Pacific District of the Shipping Board Operating Division, with headquarters at Puget Sound, Wash. Territory included in this district will be Puget Sound, Portland, Oregon, and the Columbia River terminals. This move marks the separation of the operation of the Shipping Board in Puget Sound from the San Francisco office.

Captain J. Howard Payne has recently been appointed supervisor of the Shipping Board's recruiting service for the Pacific Coast, with headquarters at Seattle. For twelve years Captain Payne was in the service of the Puget Sound Navigation Company. During the war he became commander of the merchant marine training ship *Chippewa*. In the early part of 1918 he was appointed to the Sea Service Bureau of the Shipping Board in Seattle. It was through his success in this position that he has been appointed supervisor of the recruiting service, which comprises the officers' schools in navigation and marine engineering, the Sea Service Bureau and the merchant marine training station on the coast.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

PRICES FOR U. S. VESSELS MADE PUBLIC BY SHIPPING BOARD

Craft to be Disposed of Number 1,502, and Prices Named are Generally Considered Too High—Payments Spread Over Twelve Years

In a formal announcement the Shipping Board's programme for the sale of 1,502 steel vessels, built for and owned by the Government, has been made public. The prices named for the ships range from $160 to $185 per deadweight ton, and no prices are quoted on wooden vessels. Payment of 10 percent cash, with the balance spread over a twelve-year period, are the terms on which the vessels will be sold, and there is considerable doubt among shipping men as to the response that will be made to the call for bids at the prices named, even when the easy terms of payment and the allowed mark-off for depreciation are considered. The fact that two of the 10,400--ton freigters built for the Skinner & Eddy Corporation for its own use recently sold for $144 a ton, and that vessels of a similar type can be purchased in England at less than $100 a ton, leads to the conclusion that the present prices asked by the Government are more in the nature of feeling out the market than a real indication of what the Shipping Board actually expects to get. It is generally believed that these prices will have to be revised downward before the great bulk of the tonnage is disposed of.

The Board's statement of its sales programme follows:

"The Congress of the United States has enacted and the President has approved, under date of June 5, 1920, the new Merchant Marine Act.

"Under the provisions of this act the Shipping Board is charged with the duty of adopting and executing a ship sales policy that will in fact establish the merchant marine of the United States upon a sound operating and financial basis.

"Pursuant to this duty the Shipping Board, after a careful survey of the current operating revenue, costs of operation, competitive conditions now existing and which will exist, financial and the general economic situation, offers to the public the following plan of the ship sales:

"Ten percent of the purchase price in cash upon delivery of the vessels; 5 percent in six months thereafter; 5 percent in twelve months thereafter; 5 percent in eighteen months thereafter; 5 percent in twenty-four months thereafter.

"The balance of 70 percent in equal semi-annual instalments over a period of ten years; deferred payments to carry interest at the rate of 5 percent per annum.

"All revenues derived from operations are to be deposited in a controlled or supervised account, and the instalments above provided for, except initial payments, may be paid therefrom.

"The purchaser shall be permitted to take from such proceeds of operation, after the current instalments are paid, not exceeding 15 per centum, upon paid-up instalments, as a dividend upon such investment to be distributed to stockholders of the purchasing corporations as it (the corporation) shall determine.

"Upon payment of 50 per centum of the purchase price the buyer is to execute a preferred mortgage to the Board, and thereafter the operation of the vessel is released from the supervision and control of the Board, except as to mantaining berth and route.

"The foregoing terms of sale are applicable only to new steel tonnage.

"The Board has established as minimum prices those hereinafter set forth.

"The Board will entertain bids on the various types, sizes and classes of the vessels hereinafter described, after same have been properly advertised and appraised. As is provided the price offered shall not be lower than the said minimum price. The Board at all times reserves the right to reject any and all bids.

"Types and classes of vessels, with minimum prices:

"Vessels built on Great Lakes for ocean service, coal burners, $160 per ton; oil burners, $170.

"Submarine Boat Corporation type, 5,350 tons, coal, $160; oil, $170.

"Hog Island type (American International Shipbuilding Corporation), 7,800 tons, coal, $175; oil, $185.

"Skinner & Eddy type, 8,800 tons, coal, $175; oil, $180.

"Skinner & Eddy type, 9,600-10,076 tons, and all other vessels over 10,000 tons, excepting combination cargo and passenger vessels, oil tankers and refrigerator vessels, coal, $175; oil, $185."

"The foregoing prices shall be subject to a deduction for depreciation at the rate of 6 per centum per annum for the second year of the vessel's age, and five per centum for every year thereafter to date of purchase, depreciation to be allowed for whole months only, and up to the estimated date for delivery.

"In every case the Board will insist upon full and satisfactory evidence of the financial ability of the buyer to carry out his contract and meet his financial obligations as they become due. Proof as to the nationality of the purchaser in compliance with the Merchant Marine Act, 1920, will also be insisted upon.

"Upon application the Board will furnish the names, the tonnage and general specifications of the vessels for sale.

(Signed) "United States Shipping Board,

"W. S. Benson, Chairman."

Of the 1,502 vessels to be offered 1,394 are cargo vessels, 27 are cargo and passenger vessels, 63 tankers, 15 refrigerators and 3 transports.

AMERICAN SHIPS LEAD

Interesting Figures of Ocean Commerce for Six Months of 1920

A survey of vessels entering and clearing in the foreign trade with cargo at United States customs districts, covering the first six months of the calendar year 1920, shows some very interesting features in the relations of domestic and foreign bottoms engaged in the export and import trade with the United States.

A total of 15,558 vessels of 86,931,700 deadweight tons have entered and cleared United States ports in the six months ending June 30, carrying 37,398,184 long tons of cargo. Vessels under American registry to the number of 9,550 (61.4 percent of the total vessels), aggregating 51,534,620 deadweight tons (59.3 percent of the total tonnage), carried 22,724,217 long tons of cargo (60.8 percent of the total cargo carried). The American vessels carried 44.1 percent of capacity load and the foreign vessels 41.5 percent; the average for all flags being 43 percent.

The distribution between exports and imports shows that while many of the American vessels are carrying return cargoes to United States ports, the foreign vessels are to a large extent entering in ballast and clearing with more cargo in proportion to the number and tonnage of vessels employed.

In export trade 8,114 vessels, aggregating 43,754,487 deadweight tons, carried 22,723,165 long tons of cargo. Of vessels clearing in export trade under American registry 4,995 vessels, of 25,328,050 deadweight tons, carried 11,591,446 long tons of cargo; that is 61.6 percent of the total number of all vessels employed in export and 57.9 percent of the deadweight tonnage were under the American flag, and 51 percent of the cargoes exported were carried in American bottoms.

In the imports, American vessels, numbering 4,555, aggregating 26,206,570 deadweight tons, carried 11,132,741 long tons of cargo. This was 61.2 percent of the total number of all vessels entering United States ports with cargo representing 60.7 of the total deadweight and carrying 75.9 percent of the commodities imported.

The average export load of all vessels was 2,800 long tons, of 51.9 percent of the deadweight employed. American vessels carried an average of 2,320 tons per vessel, or 45.7 percent of deadweight, while foreign vessels averaged 3,248 long tons, or 60.4 percent of deadweight. The imports averaged 1,972 long tons per vessel, or 33.9 percent of deadweight employed. American vessels averaged in imports 2,444 long tons, or 42.1 percent of deadweight per vessel, while foreign vessels only averaged 1,226 long tons, or 20.1 percent of deadweight per vessel.

In the export trade American vessels employed 2.19 deadweight tons of vessels to transport 1 long ton of cargo, while the foreign vessels utilized 1.93 deadweight tons of vessel for each long ton of cargo carried. This situation was reversed in the import trade, as American vessels employed 2.35 deadweight tons for each ton of cargo, while the foreign vessels used 4.79 deadweight tons for each long ton of cargo entering American ports.

The total tonnage employed in both export and import trade by all flags was 2.32 deadweight tons of ship for each long ton of cargo carried.

A comparison of reports of the Bureau of Foreign and Domestic Commerce for the calendar year 1919, based on the net tonnage of all vessels clearing with cargo in export trade, shows that 42 percent of the net tonnage was under the American flag and 58 percent under foreign. Of vessels entering in import trade for the same year, 51.1 percent were American and 48.9 percent were foreign.

No German Money in U. S. Mail Company

Admiral Benson has stated that the contract between the United States Mail Steamship Company and the North German Lloyd contemplates the renting of the piers and other facilities at Bremen with the employment of Germans on salaries as agents for the company. The Germans will not be allowed financial interest in the company.

Most of the ex-German liners chartered to the United States Mail by the Shipping Board will be delivered by the end of the year, and services will be inaugurated as soon as the reconditioning of the vessels can be completed.

HOG ISLAND YARD TO BE SOLD BY SHIPPING BOARD

Largest Shipbuilding Plant In the World To Be Disposed of—Has Turned Out 122 First Class Vessels

The enormous plant constructed by the American International Shipbuilding Corporation for the Shipping Board Emergency Fleet Corporation is to be sold on bids to be received by the Sales Division of the Shipping Board up to September 20. This announcement disposes of the flock of rumors which have been circulated regarding the disposition of the big plant when its work for the Government was ended, and leaves for an answer the question as to what interests are big enough to take over the establishment and make profitable use of it.

Under the war programme 122 vessels were constructed for the account of the Shipping Board, and have proved to be some of the best built for the Government.

The Board stated that it would give possession of the plant on October 1 upon completion of the present building programme. Title will remain with the Emergency Fleet Corporation until it is completely paid for by the purchaser.

Hog Island has an area of 946 acres, water frontage of two miles, twenty-seven warehouses, eighty-two miles of railroad tracks, twenty-one miles of roads, fifty shipbuilding ways, sewerage and drainage, seven steamship piers, administration, record and telephone buildings, shop buildings adaptable to terminal uses, power, air, electric, steam, water and oil lines, classification yards and complete fire protection.

The four-story concrete warehouses and the twenty-six wooden warehouses, with a total floor area of more than one and three-quarter million square feet, are so designed as to be available as storage bases in a terminal. Each warehouse is served by a railroad track, and has a platform adjoining a street for its entire length.

The total floor space of all buildings, 4,505,000 square feet, is equivalent to 103 acres, of which 24 percent is fireproof.

Each of the piers is equipped with four self-propelling gantry cranes, with sufficient clearance to permit the operation of standard locomotives and cars. In addition each pier is equipped with two locomotive cranes and Pier B with a bridge crane, span of 118 feet and lifting capacity of 100 tons. Between piers there is 266 feet of clear water space, which permits the docking of four ships in each

There are 50 ways, 40 wood, 10 concrete, each equipped with fixed stiff leg derricks. Hog Island also has 10 electrically equipped pumping stations, 75 miles underground cables, 45 miles fiber duct laid in concrete, filtration plant, sewage disposal plant, which with the other appliances, facilities and equipment provides it with the fundamentals for the best arranged and modernly equipped terminal and storage yard in the country.

Sealed bids will be received until 1 P. M., September 20, 1920, by the Supply Sales Division, United States Shipping Board Emergency Fleet Corporation.

Title to the property will remain in the hands of the United States Shipping Board Emergency Fleet Corporation until full purchase price has been paid.

The right to reject any or all bids is reserved.

D. H. Cox Has an Assistant

Daniel H. Cox, secretary-treasurer of the Society of Naval Architects and Engineers, announces that Thomas J. Kain has been appointed as his assistant, and hereafter will be in constant attendance at the society's room, 29 West Thirty-ninth Street. Mr. Kain has assisted for many years in the secretarial duties of this society in a most efficient and faithful manner, and with his long experience should prove of great help to the members. This society is headquarters for the principal marine engineers and naval architects of the country. Its library contains 150,000 volumes and pamphlets on technical subjects. For the benefit of members unable to visit the library in person, lists of references to engineering subjects or technical works, and copies or translations of articles are furnished on request. Engineers and naval architects are to be congratulated upon having such an admirable organization at their disposal.

SHIPPING BOARD SUED

Pusey & Jones Shipyard Case Taken to United States District Court

Differences between Christoffer Hannevig, of the Pusey & Jones Company, and the United States Shipping Board regarding compensation for construction of ships and damages resulting from cancellations of contracts, have been brought into the United States courts through a petition filed in the District Court in Washington by Charles E. Hughes, of counsel for Mr. Hannevig, seeking to restrain the Emergency Fleet Corporation from withholding payment of $7,194,475 authorized by the Shipping Board on March 13 last as "just compensation." The action reveals why the reported sale of the Gloucester, N. J., shipyard to the Baltimore Dry Docks & Shipbuilding Company was not completed.

THE MARINE EXPOSITION AT CHICAGO, OCTOBER 18-23

Importance of An American Merchant Marine to be Visualized; Shipping Board to Exhibit Largest Metal Map of World Ever Made

"National Marine Week," in conjunction with the great National Marine Exposition at the Grand Central Palace, New York City, under the auspices of The National Marine League, did a great missionary work in bringing home the importance of an American merchant marine adequate to the country's needs. It visualized to the 70,000 visitors at the exposition the economic value to a nation of resources that have produced as fine a fleet as can be found under any flag. It enabled them to understand Jefferson's apothegm, "In shipping all industries meet." "Keep the Flag Flying" is the slogan of the League, and to further this idea a series of Marine Expositions have been planned.

The next exposition will take place at the Coliseum in Chicago during the week of October 18 to 23, 1920. The object of this exposition will be threefold:

First. To focus the attention of the voting population of the Middle West on the great and constantly increasing importance of America's merchant sea power in relation to the maintenance of inland prosperity.

Second. To impress the public of the entire country with the wealth and magnitude of our lake and inland water shipping, to the end that this part of the nation's transportation problem may receive the serious and intelligent attention of both national and State law makers.

Third. To provide a market place where buyer and seller of ships, service and marine equipment may conveniently meet and do business.

The United States Shipping Board will be one of the prominent exhibitors at this exposition. It will have among its exhibits the largest metal map of the world ever made. It will be in bas-relief and will require about two tons of metal. Its measurements will be 15 by 42 feet. Admiral Benson, chairman of the Shipping Board, will open the exposition.

John Barton Payne, former chairman of the United States Shipping Board, has emphasized the importance of inland water transportation in the United States, and points out that the Great Lakes transportation system, important as it is at present, is in its infancy, and that delay in its development will cost producers, shippers and consumers millions of dollars yearly. "The importance of Chicago alone," he says, "not only as a manufacturing and packing center, but also as a clearing house for shippers generally west of Illinois, argues strongly for bringing to the highest possible state of accessibility and efficiency all means of freight transportation." Hon. J. W. Alexander, Secretary of the Department of Commerce, in a recent letter to Mr. P. H. W. Ross, president of The National Marine League, commenting on the National Marine Exposition held in New York City, wrote in part: "I sincerely wish a similar exposition might be held in some of our large cities in the Central West. It would do much to increase the interest of the people in the Central West in our merchant marine. I am losing no opportunity to drive home to our people in the Central West the fact that they are vitally interested in this great question."

UNION PLANT'S BIG DOCK

Bethlehem Corporation's San Francisco Plant Gets Important Addition

The Bethlehem Shipbuilding Corporation, Ltd., announced late in August that the new 12,000-ton floating dry dock at its Union plant, San Francisco Bay, is expected to be ready for full operation on September 1. The dock was purchased, when nearly completed, from the Ames Shipbuilding Company at Seattle, and was towed to San Francisco.

With this dock in position the Union plant—which has docked 2,500 vessels in thirty-two months—will have facilities for docking unrivaled on the Pacific. The new dock is in four sections, each 90 feet long by 126 feet wide. The total length of the dock over the aprons is 421 feet 6 inches.

The Alameda works of the plant also has extensive graving docks, all cut out of solid rock and lined with concrete. One of these is the largest in the world, being 1,020 feet long, 153 feet wide at the top and 86 feet wide at the bottom. A second dock is 750 feet long. This plant also has two large marine railways, and is adding 60,000 square feet to its already large wharfage space, and also 2,500 lineal feet of berths for ships. Its new piers are built with creosoted piling, which resist the ravages of the teredo worm.

The Union plant's complete facilities are the largest on the Pacific Coast, including 75 fireproof buildings with 1,500,000 square feet of floor space, all equipped with modern machinery, and a very large assortment of modern shipbuilding equipment.

A floating dry dock of 2,500 tons capacity, until recently used at the Alameda works, will be removed to the Potero works, giving the latter four floating docks of 23,000 tons combined lifting capacity.

THREE COMPANIES MERGED

Harriman Interests Form Big Steamship Combination

Announcement has been made by W. A. Harriman, president of the American Ship & Commerce Corporation, and senior vice-president of the American-Hawaiian Steamship Company, that his companies have purchased the firm of Livermore, Dearborn & Company, Inc., and will operate the joint fleets and shipping concerns controlled by them. The joint concerns, to be known as the United American Lines, will control ships of about 600,000 aggregate deadweight tonnage. The operating contract which the Kerr Navigation Company has with the American Ship & Commerce Corporation will be canceled under a provision for a ninety days' notice of such intention.

The operating division of the combined companies will be located at 8 and 10 Bridge street, New York, and the executive offices of American Ship & Commerce will be in the new Kerr Line building.

The vessels to be operated by the United American Lines are:

Kerr Navigation Company fleet—*Keresan, Kerlew, Kerowlee, Kerkenna, Kerespa, Kermoor, Kermit, Kermanshah, Monticello, Montpelier.* Total, 10.

American - Hawaiian fleet — *Alaskan, American, Arizonian, Dakotan, Floridian, Hawaiian, Iowan, Kentuckian, Mexican, Minnesotian, Ohioan, Oregonian, Panaman, Pennsylvanian, Texan, Virginian, Missourian* (building), *Californian* (building). Total, 18.

Coastwise Transportation fleet—*Corsica, Franklin, Hampden, Middlesex, Norfolk, Suffolk, Plymouth, Transportation, Clarksburg, Steamer.* Total, 10.

Shawmut fleet—*Mystic, Ipswich, Sudbury*, two building. Total to be 5.

American Ship & Commerce Corporation — *DeKalb*, ex-German passenger steamer. Total, 1.

Livermore, Dearborn fleet—Shipping Board steamers. Total deadweight between 150,000 and 200,000.

All the vessels of the Kerr fleet are ex-Austrians, purchased three years ago by consent of the Shipping Board, except the *Montpelier* and *Monticello*, which are ex-German.

Rotterdam-Seattle Service

Representatives of the Holland-American Line announce plans for the inauguration of freight and passenger service between Seattle and Pacific Coast ports and Rotterdam, Antwerp, London, Liverpool, Hamburg and other European ports. Three 12,000-ton freighters have been named for the Pacific, loading in Seattle, to commence with the steamer *Eemdyke* in October. The freighters will be fitted with large cooling rooms and refrigerators for the transportation of fresh fruit, fish and other Puget Sound products. For the present cargo carriers only will be sent to the Pacific.

PLANS BIG DEVELOPMENT

$35,000,000 for Tankers to be Expended by Atlantic, Gulf and West Indies

The Atlantic, Gulf & West Indies Steamship Lines, which is associated with the building of a pipe line to carry petroleum between Havre and Paris, is, it is reported, planning to expend between $50,000,000 and $60,000,000 in connection with the development of its oil properties. More than half of this amount, or about $35,000,000, will be used to purchase tankers for the transportation of its Mexican oil. A fleet of fourteen tankers is already under construction.

It is stated that no new financing is contemplated in connection with the big expenditure. The company is said to have available at the present time about $50,000,000 for the purposes contemplated. The company made large profits during the war and amassed a big surplus.

It is planned to expend about $10,000,000 on the development of its Mexican properties and from $8,000,000 to $10,000,000 will be expended in the construction of pipe lines. It is asserted that the major portion of the French undertaking, which calls for the construction of refineries, storage tanks and pipe lines, will be financed by Atlantic, Gulf and West Indies. About $2,000,000 will be spent on the development of properties in England, which have recently been acquired. In connection with the British project the Agwi Petroleum Corporation, Ltd., has been formed, with a capital of £1,000,000, and 65 percent of the stock is owned by Atlantic, Gulf & West Indies. Recently 466 acres of ground were purchased at Southampton, England, and on this property a topping plant will be erected.

The development work in Mexico is being carried on on an extensive scale.

JULY'S REGISTER RECORD

171 Vessels Numbered in Month by Navigation Bureau

One hundred and seventy-one sailing, steam, gas and unrigged vessels, aggregating 214,840 gross tons, built in the United States, were officially numbered in July, according to the Bureau of Navigation of the Department of Commerce.

Of these, 95, of 125,196 tons, were built on the Atlantic and Gulf coasts, 51, of 75,892, on the Pacific Coast, 21, of 13,671, on the Great Lakes, and 4, of 81 tons, on Western rivers. Twenty-four of the vessels of a total of 147,699 tons, were built for the Shipping Board.

Two vessels, the steel steamer *Julius Kessler*, 2,359 gross tons, and gas schooner *Fidelity*, of 40 gross tons, built in the United States for foreign account, were also numbered in July. The *Julius Kessler* is owned by the Julius Kessler Corporation, and flies the British flag.

From sources other than construction, two vessels of 11,552 gross tons were admitted to American registry under the act of September 7, 1916, two of 441 gross tons under the act of August 18, 1914, one of 8,797 gross tons under joint resolution of Congress, May 12, 1917, and one of 93 gross tons as a prize. Total six vessels of 20,883 gross tons.

DETAILS OF GERMAN SHIP DEAL

Combined Fleet to Be Run on 50-50 Basis—Passenger Ships to be Built

Details of the contract between the Harriman steamship interests and the Hamburg-American Line, recently made public, show that the agreement is on a partnership basis, in which the Germans share equally in all rights and privileges with the Americans. The resultant combined fleet is to be operated on a strictly 50-50 basis. Each side has the privilege of flying its own flag on 50 percent of the combined fleet. The Hamburg-American Company will fix rates on westbound traffic and the United American Lines, Inc., the operating company for the Harriman interests, will fix those on eastbound traffic. Lines will be operated to various ports of the world. There is to be an interchange of docking facilities. The contract is for twenty years. No statement is made as to what is contemplated beyond that period.

Under the contract, the American company has guaranteed to place 40,000 tons of steerage tonnage in operation between American and German ports before July, 1921. Plans are to be completed for the construction of four passenger liners of intermediate type, costing from eight to ten million dollars each, two to fly the German flag and two the American. The German ship *DeKalb*, now being reconditioned at the Morse works at South Brooklyn, will be used in the American company's passenger service, as well as two 13-knot ships now building by the Merchant Shipbuilding Corporation, which will be converted to third-class passenger carriers.

According to the contract "each service is considered a unit," and each side "may transfer for execution" any service covered by the contract to any other company of the same nationality. Disputes are to be settled by arbitration.

No German money is to be invested in the American company. The contracting parties are to have reciprocal advantages in developing trade, and each is to furnish agents in its own country for the other. Negotiations for the deal have been conducted by W. G. Sickel, formerly representing the Hamburg-American.

R. H. M. Robinson, president of the Merchant Shipbuilding Corporation, will soon leave for Germany to consult with the designers of the Hamburg-American Line regarding new tonnage for that line. It is stated that the Hamburg-American interests placed an order for 185,000 gross tons of ships before the contract was signed.

TO BUILD BIGGEST FIGHTER

Fore River Yard to Construct the Lexington, World's Greatest Battleship

The Fore River (Quincy, Mass.) yards of the Bethlehem Shipbuilding Corporation, Ltd., is to begin construction, within a few months, of the United States battleship *Lexington*, which will be larger and more heavily armed than any American, French, British or French boat built or building.

She will carry eight 16-inch guns in her main battery, with a plentiful supply of smaller guns. Her speed, estimated at 35 knots, will be obtained in part by the use of thin armor plate, which, while only 5 inches in thickness, will be of much greater strength than any now in use.

The *Lexington* will be 874 feet long over all, with 101 feet beam, and will displace 43,200 tons. She will be an oil burner, with electric drive, and will develop 180,000 horsepower. She will be larger and four knots faster than the British battleship Hood, now building.

Chicago Section American Welding Society Organized

At a meeting of members of the welding trade in Chicago, in the rooms of the Western Society of Engineers, on August 3, a Chicago section of the American Welding Society was organized. There were about seventy-five in attendance, representing many railroads terminating in Chicago, also many of the larger local industries. The following officers and directors were elected: Chairman, M. B. Osborn, assistant superintendent, Pullman Car Works; vice-chairman, O. T. Nelson, president, General Boilers Company; secretary-treasurer, L. B. Mackenzie, president, *The Welding Engineer*.

Directors—Three Years.—E. Wanamaker, electrical engineer, Rock Island Railway; H. B. Bently, superintendent motive power and machinery, C. & N. W. Ry.; Andrew Oliver, welding supervisor, Standard Oil Company; W. M. B. Brady, commercial engineer, General Electric Company. Two years—Harold Cook, managing editor, *Acetylene Journal;* W. A. Slack, president, Torchweld Equipment Company; K. R. Hare, district manager, Transportation Engineering Company; J. M. Jardin, partner, Western Welding & Equipment Company. One year—W. H. Bleecker, Jr., district manager, Page Steel & Wire Company; Oliver Mitchell, partner, A. F. Mitchell & Son; Walter L. Senhert, president, Welded Products Company; Don B. McCloud, secretary-treasurer, Gas Products Association.

Meetings will be held on the second Tuesday of each month in the rooms of the Western Society of Engineers, and those interested in the subject of autogenous welding, by all methods, are invited to attend. The address of the secretary-treasurer is 608 South Dearborn street, Chicago.

57,314,000 GROSS TONS IN WORLD STEAM AND SAILING FLEETS

British Pre-War Lead Reduced To About 2,300,000 Tons—America Behind In Steel Tonnage, But Ahead In Wooden, Both Steam and Sail—Changes In Proportional Growth.

Despite the great growth of the American merchant marine and the intensive production of ships in the United States and the United Kingdom, the world's steel steam tonnage to-day is three and a half million gross tons less than it would now have been if the war had not interfered with the normal rate of expansion, says a statement just issued by Lloyd's Register of Shipping, and based on data contained in the 1920-21 edition of Lloyd's Register Book.

Although Britain is now building nearly 1,500,000 gross tons of ships more than this country, it is stated British holdings of steamers are still 781,000 tons below the total at the outbreak of war.

The world total for all types of vessels over 100 gross tons, however, is now 57,314,000 gross tons, an increase of 8,225,000 tons over the pre-war figure. Of this amount the United States holds 16,049,000 tons and the United Kingdom 18,330,000 tons, the British lead, which before the war was nearly 14,000,000 tons, having been reduced to about 2,300,000 tons.

In steel steamers, however, the British lead is a larger one, the margin in this case being 4,686,000 tons. American holdings of wooden steamers are much greater than the British, and this country also leads in sailing tonnage by a wide margin. The distribution of the tonnage of the two countries by types is as follows (in gross tons):

	United States	United Kingdom
Steel steamers	13,113,000	17,798,000
Iron steamers	227,000	277,000
Wooden steamers	1,234,000	35,000
Total steamers	14,574,000	18,110,000
Sailing ships	1,475,000	220,000
Total all ships	16,049,000	18,330,000

Holdings of all types of vessels by the two countries and the other maritime nations at June 30 of 1914, 1919 and 1920, are given by Lloyd's Register as follows (figures in gross tons):

	1914	1919	1920
United States	5,368,000	13,092,000	16,049,000
United Kingdom	19,257,000	16,555,000	18,330,000
Other countries	24,464,000	21,272,000	22,935,000
World total	49,089,000	50,919,000	57,314,000

These figures indicate that while the United States has trebled its pre-war holdings, Great Britain and all the other maritime nations combined are still about two and a half million tons below their 1914 total. During the past year the American merchant marine grew by nearly three million tons, while the United Kingdom's gain was only about half that, with the other nations advancing about the same amount.

The reduction in the world's sailing tonnage since 1914 has been 641,000 tons, a much smaller decrease than in the previous six-year periods. This would seem to show that the general shortage of tonnage has to some extent given new life to the construction of sailing vessels. The United States is the only country which has increased its volume of sailing tonnage since the beginning of the war, and it now owns 43 percent of the world's total. The proportion of sailing vessels in the world's tonnage is now under 6 percent, as compared with 8 percent in 1914 and 22 percent in 1902.

According to the new Register there are now 5,082 sailing vessels of 3,409,000 tons and 26,513 steamers of 53,905,000 tons, making a world total of 31,595 vessels of 57,314,000 tons. Apart from Germany and Austria the United Kingdom and Greece are the only nations which show any considerable reduction in the steam tonnage now owned as compared with 1914. Denmark and Sweden show minor losses and Norway a small gain. Most of the other countries have increased in tonnage holdings, some to a very considerable extent.

The seagoing tonnage of the United States has increased nearly 10,400,000 tons, an advance of over 500 percent on the 1914 figures. The other countries in which the largest increases are recorded are: Japan, 1,288,000 tons; France, 1,041,000 tons, and Italy, 638,000 tons. As in the case of the United Kingdom, the figures for France and Italy include a considerable amount of ex-enemy tonnage provisionally allocated to those countries.

How the maritime position of Germany has changed is shown conclusively by the figures. While in 1914 Germany occupied, after the United Kingdom, first place, with over 5,000,000 tons of merchant steamers, only 419,000 tons are now recorded in the Register Book as German, everything else having been either captured, requisitioned, sunk or allocated to the Allies in accordance with the peace treaty.

The relative positions of some other countries has also altered to a large extent. In 1914 the United Kingdom owned 41.6 percent of the world's steam tonnage, while the present figure is 33.6 percent. Norway, which occupied the fourth place, is now seventh, while Japan, which was sixth, is now third.

Excluding vessels trading on the Great Lakes (about 2,300,000 tons), the United Kingdom percentage of the world's seagoing steam tonnage has decreased from 43.9 in 1914 to 35.1 in 1920; while the proportion of the United States, which was 4.7 percent six years ago, has now reached 24 percent.

The Register shows that nearly 27,750,000 tons of shipping are actually cleared or about to be classed by Lloyd's, and that the existing vessels which were formerly classed total about 8,850,000 tons. That the recognition of the value of classification is world-wide is shown by the fact that of the more than 25,000,000 tons of vessels actually appearing as classed in the new book, 14,000,000 tons are of vessels owned outside of Great Britain. Of the total steel and iron merchant tonnage now in existence about 62 percent has been built under the survey of Lloyd's Register. During the calendar year 1919 the new vessels classed by Lloyd's aggregated 4,283,000 tons, of which nearly 2,200,000 were built in the United States.

SEATTLE'S GREAT PIER

Opened for Service With 946,860 Square Feet of Floor Space

Seattle's new Pier B at the Smith Cove Terminal, the largest cargo pier in the world, opened August 5, when the Mitsui steamship *Horaisan Maru* was docked at one end of the great structure, which is 2,580 feet long and 367 feet wide, having an area of 946,860 square feet. Eleven ships the size of the *Horaisan Maru* can discharge cargo at this waterfront giant simultaneously. The *Horaisan Maru* brought a cargo of 8,344 tons. The terminal now consists of two piers, A and B, and together they form a whole port in themselves, capable of handling millions of tons of cargo each year. There are 68 other cargo piers along the waterfront.

The estimated cost of new transit shed and passenger accommodations on Pier B is $232,644. The Pacific Steamship Company will dock its Oriental passenger liners which will be sent to the Pacific Coast by the Shipping Board at this terminal, starting in September, at Pier B.

Tanker Construction August 1

According to a statement by the Atlantic Coast Shipbuilders' Association, as of August 1, at present 119 tankers of 812,325 total gross tonnage are ordered from or building in American shipyards. This is an increase in tanker orders on hand of 9,000 tons compared with May, and 67,185 compared with April.

3,554,352 Tons Built in Year

During the twelve months ended July 31, this year, American shipyards turned out 2,086 vessels of 3,554,352 gross tons. Of these, 674 were steel ocean steamers, aggregating 3,146,257 gross tons. Twenty-four vessels of 147,699 gross tons were built for the United States Shipping Board.

PERSONAL NOTES

P. I. Rhodes has been appointed New York representative of the Union Shipbuilding Company, of Baltimore, with offices at 50 Church street.

Louis F. Swift, of the Chicago packing firm of Swift & Company, has resigned from the directorate of the Green Star Steamship Company, 115 Broadway.

Colonel Guy Goff, general counsel for the Emergency Fleet Corporation, will also be general counsel for the Shipping Board, placing the legal departments of both organizations under one head.

Brigadier-General Frank T. Hines, whose recent resignation from the army came as a surprise, has entered the steamship business as general manager of the Baltic Steamship Company, 17 Battery Place, New York.

Lester C. Neff has resigned his position as Galveston agent of the Shipping Board, and will come to New York as assistant general manager of the Export Steamship Company, Inc., better known as the Oriole Steamship Company of Baltimore.

A. J. Frey, director of construction and repair of the Emergency Fleet Corporation, has resigned, and will become manager of the Los Angeles Steamship Company. He was formerly connected with the old Pacific Mail Steamship Company.

Frederick A. Jones, formerly vice-president and general manager of the Eastern Steamship Corporation, with headquarters at Boston, and during the war in the employ of the United States Shipping Board, has been appointed manager of the Hobbs Manufacturing Company at Worcester, Mass.

Calvin Tompkins, former president of the American Association of American Port Authorities, and former Dock Commissioner of New York City, has been on an inspection tour of Pacific Coast ports, and was the guest while at San Francisco of J. B. McCallum, president of the California State Board of Harbor Commissioners.

The National Safety Council announces the appointment of R. T. Read, of the safety department of E. I. du Pont de Nemours & Company, as permanent secretary of the Delaware local council; also of J. C. Townsend, formerly safety engineer for the International Shoe Company, of St. Louis, as manager of the Grand Rapids division of the National Safety Council.

Mr. Charles M. Manly, who during the war was busy with the production of aircraft, has finished his term of office as president of the Society of Automotive Engineers, and in connection with Mr. C. B. Veal, under the firm name of Manly & Veal, consulting engineers, has opened offices at 250 West Fifty-fourth street, New York, for the investigation of industrial propositions, the rehabilitation of manufacturing concerns, and the installation of inspection systems that operate to increase production and decrease costs of manufacture.

TRADE PUBLICATIONS

Rock Drills.—Bulletin 504, recently issued by the Chicago Pneumatic Tool Company, 6 East Forty-fourth street, New York, describing the Slogger rock drill, is now available, upon request, from the New York office or any branch office.

Adjustable Speed Motors.—This bulletin describes recent developments in the design of R F, Form A, direct-current adjustable speed motors, produced by the General Electric Company, Schenectady, N. Y. Complete specifications are also given to aid in the replacement of worn parts of these motors.

Windlasses.—A pamphlet describing spur geared ships' windlasses has been issued by the S. Flory Manufacturing Company, Bangor, Pa. In the construction of this new windlass steel instead of cast iron is used wherever possible, so that the machine is capable of withstanding the heaviest service. Steel spur gears are used for the drive instead of worm gears usually found in windlasses.

Marine Glue.—In a pamphlet issued by L. W. Ferdinand & Company, 152 Kneeland street, Boston, Mass., the uses of Geoffrey's marine glue are described. Among other applications of this glue may be mentioned backing for armor plates, covering for deck and hull seams, making hollow spars for covering small boats and decks with canvas. In each case directions are given for applying the glue where it is to be used in connection with linen or canvas.

The Compass.—The latest issue of the Vacuum Oil Company's bulletin contains an account of the construction contest between two new tankers which were being built at the Sparrow's Point yard of the Bethlehem Shipbuilding Corporation and at the Moore yard of the Bethlehem Shipbuilding Corporation. This issue also includes the requirements for motorboat engine lubrication, as well as an excellent collection of photographs of the company's tanker float.

Fan Systems.—The most recent publication of the Buffalo Forge Company, Buffalo, N. Y., Catalogue No. 700, contains valuable engineering data on the design and installation of heating, ventilating and humidifying systems for all purposes. In fact, complete calculations for the apparatus to be used in connection with any of these services are carried out, special examples being used to illustrate their application. Charts and tables dealing with the three subjects have been compiled so that the catalogue is in effect a handbook of ventilating and heating.

Deflection Potentiometer.—The second edition of the General Electric Company Bulletin No. 46112, describing the deflection potentiometer has just been issued. This instrument is designed particularly for giving accuracy between the precision potentiometer and the laboratory standard. There are certain changes in the design and the arrangement of the circuits mentioned, which permit measuring potential up to 1.5 volts to within 0.0002 volt without a volt multiplier. Current may also be measured by means or shunts giving direct ampere readings.

Refrigerating Plants.—The Norwalk Iron Works Company, South Norwalk, Conn., gives a complete description of its new product, the "Norwalk" refrigerating plant, in Bulletin No. 6, which has recently been issued. Various types and capacities of this machine, both for land and marine installations, are completely illustrated. The special features of the plant are its compact and sanitary arrangements, and the fact that it requires but little attention for satisfactory operation. The company will be interested in supplying complete information and submitting quotations for refrigerating or ice-making plants of any size or covering any special requirements.

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AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

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39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVALI E MECCANICI IN ITALIA,
Via Carlo Alberto 18, Genova.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Tanker, Chester, Pa.—One of 12,000 deadweight tons for the Sun Company, of Philadelphia, is to be built by the Sun Shipbuilding Company.

Boat Building Plant, Seattle, Wash.—The Tregoning Boat Company is constructing a new plant for building small boats. Frank Tregoning is president.

Tankers, Portland, Ore.—The Standard Oil Company of New Jersey has contracted with the G. M. Standifer Construction Company, of Portland, Ore., for two tankers of 8,000 tons each.

Converting Steamer, Seattle, Wash.—J. F. Duthie & Company have undertaken to convert the Japanese-built American steamer, Eastern Exporter, into an oil burner for $101,396.

Passenger Steamer, San Francisco, Cal.—A contract for building a 16,340-ton passenger and cargo steamer for the Southern Pacific & Atlantic Steamship Company has been let to the Moore Shipbuilding Company.

Tanker, Chester, Pa.—A contract was placed by the Tidewater Oil Company with the Sun Shipbuilding Company for the construction of a 10,000-ton tank steamer on which work will probably begin within the next few weeks.

Tankers, Portland, Ore.—The Northwest Bridge & Iron Works has contracts for seven oil tankers for Canadian interests. The ships will be 12,000-ton capacity and the plant will employ 5,000 men. The second keel was laid a few weeks ago.

Steam Schooner, Portland, Ore.—The keel for a steam schooner for the Hart-Wood Lumber Company was laid at the Peninsula Shipbuilding Company's yard. The ship will have a capacity of 1,200,000 feet of lumber, and will cost about $100,000.

Reconditioning Steamer, New York.—New bids are being asked by Ferdinand Eggena, 17 Battery Place, New York, for the reconditioning of the ex-German steamer Von Steuben, which he recently purchased. The estimated cost is $3,000,000.

Shipbuilding Machinery, Bath, Me.—It is reported that the Hooven, Owens, Rentschler Company, of Hamilton, Ohio, and 39 Cortlandt street, New York, has sold to the Bath Iron Works a large order of marine construction and shop machinery.

Cargo Steamers, Baltimore, Md.—The Union Shipbuilding Company is about to lay the keels for two 9,500-ton cargo steamers that it is building for yard account. Keels for two 9,700-ton tankers for the Gulf Refining Company were recently laid.

Coal Barge, Linton, Ore.—Plans have been completed by Supple & Martin to convert a half-finished wooden Shipping Board hull into a coal barge for use in the local harbor. The barge will be equipped with powerful cranes and tracks, on which coal cars can be run.

Tankers, Camden, N. J.—W. R. Grace & Company have contracted with the New York Shipbuilding Corporation for building a 10,000 deadweight ton tanker. One of the 9,800 deadweight ton tankers of the Pacific Mail Steamship Company is also to be built by the company.

New Shipbuilding Company, Milford, Conn.—The Milford Shipbuilding Company, recently organized, has acquired about 22 acres on the Housatonic River for the erection of a plant. Initial equipment will be for the production of light draft boats, power operated, for coastwise service.

To Use Wooden Hulls.—Several of the Shipping Board's idle wooden hulls on the Pacific Coast are to be converted into barkentines for overseas business by a Seattle concern called the Pacific Packet Line. The Winneton Shipping Company, a new concern, is connected with the packet company.

Shipbuilding Company Liquidates, Three Rivers, Que.—The Three Rivers Shipyards Company, Ltd., a subsidiary of the National Shipbuilding Company, New Orleans, La., has gone into liquidation, and a meeting will be held in the near future to appoint a liquidator who will wind up the affairs of the company.

Company Reorganized, Northport, L. I.—The Northport Shipbuilding Corporation has filed notice of dissolution, to be superseded by the Northport Shipyards, Inc., organized with a capital of $100,000. H. E. Bogdish, M. D. Flomenhaft and G. N. Dorney, 244 West 134th street, New York, are the incorporators.

Whalers, Oakland, Cal.—Two electrically-driven whalers, each 100 feet long, and said to be the most efficient craft of their kind ever devised, are under construction at the Barnes & Tibbitts yards for a new whaling concern, which will build a plant and operate from Drakes Bay, just north of the Golden Gate.

Completing Steamer.—The Shipping Board expects to complete the first of the new 12,600-ton passenger liners being built in Pacific Coast yards for traffic with the Orient by September 15. It will be named the Wenatchee, and will be operated by the Admiral Line, a subsidiary of the Pacific Mail Steamship Company.

Steamers, San Pedro, Cal.—Two new steamers, to cost $4,000,000 each, will be built for the Admiral Line. The Southwestern Shipbuilding Company and the Los Angeles Shipbuilding Company, both of San Pedro, have been requested to bid on the work of construction. The vessels will be 560 feet in length and have a gross tonnage of 21,000.

Barges, Mobile, Ala.—The Murnan Shipbuilding Company's contract with the Marion Oil Company, of Tampico, Mexico, calls for the completion of ten 7,500-barrel oil barges and a tugboat by November. Two of the contracts for twelve barges have just been completed. It is also building barges for J. O. Williams, of Havana, for use in the sugar trade.

Subchasers as Fishing Boats.—North Pacific fishermen are reported to have purchased some of the Government's submarine chasers which have been offered for sale and converted them into fishing boats, which have proved very successful. It is expected that a large number of the chasers now laid up will be used for that purpose in the near future.

Ocean-going Tugboats, Pensacola, Fla.—The Pensacola Shipbuilding Company will undertake the construction of a number of large ocean-going tugboats, according to an announcement made at the plant directly after the last of the large steamships went into the water. The work of fabricating the steel for the first of the 1,400-ton tugs was started August 2.

Reconditioning the DeKalb, Brooklyn, N. Y.—The Morse Dry Dock & Repair Company has the contract for reconditioning the DeKalb, ex-Prinz Eitel Friedrich. The contract calls for 120 working days and will require the services of hundreds of ship repairers. The DeKalb is of 8,797 gross tons, 55 feet 7 inches beam, 32.1 depth, and 506 feet long.

Repair Steamers, Baltimore, Md.—The Baltimore Dry Docks & Shipbuilding Company has been awarded a contract to repair the steamship Nantucket, of the Merchants & Miners Transportation Company, to cost about $150,000. The steamship Kershaw of this line will also undergo repairs to cost about the same price. Four new Scotch boilers are to be installed.

Subchaser for Fireboat, Seattle, Wash.—Purchase from the Federal Government of one or more subchasers for conversion into fireboats was suggested to the City Council of Seattle by Frank L. Stetson, chief of the Seattle Fire Department. Two of the boats available are at the Puget Sound Navy Yard. They originally cost $80,000, but will be sold for $12,000.

Schooners, Boothbay, Me.—Some time in October the four-mast schooner Zebedee E. Cliff is to be launched at the yard of the East Coast Ship Company. At the Atlantic Coast yard, owned by Crowell & Thurlow, of Boston, the Joshua B. Merrill, a sister ship of the four-master J. W. Howard, will be launched in December, and the keel for another has been stretched.

Ships to Be Sold in Seattle, Wash.—Negotiations are in progress for the sale of the motorship Muriel, recently launched from the Anderson's Lake Washington Shipyard, and the Donna Lane, a sister ship. The lumber carrying capacity of each vessel is 1,736,596 feet, the underdeck capacity being 1,293,792 and the deck load capacity 442,804 feet. Each ship has three hatches.

Barge, Winslow, Wash.—The first of the Shipping Board's Ferris type ships to be converted into an ocean-going barge was launched from the Winslow Marine Railway & Shipbuilding Company's yard at Eagle Harbor, for the Coastwise Steamship & Barge Company. When in commission this barge will be equipped with the most modern towing devices as well as cargo-handling apparatus.

Trawlers, East Boothbay, Me.—Two steel trawlers are on the ways at the Rice Bros. yard, and two others are under way outside. Work on them has been suspended for some time, but it is expected they will be started up again soon. The vessels are 152 feet long, 24 feet beam and 15 feet deep. The Rice Bros. have developod their former small boat plant into a well-equipped steel shipbuilding concern.

Steamer, Bath, Me.—The Bath Iron Works has secured a contract from Crowell & Thurlow, of Boston, to build another 9,500 deadweight tons steamer to be a duplicate of the one now on the ways. She will be 410 feet long, 55 feet beam and 34.5 feet deep, with triple expansion engines, and a speed of 10 knots. There will be three Scotch boilers, and the furnaces will be designed to burn eithr coal or oil.

Tankers, Sparrow's Point, Md.—The Bethlehem Shipbuilding Corporation's plant will lay the keel for the first of two oil tankers for the Lux Navigation Company of London, England, in September. The vessels will have an overall length of 427 feet,, with a beam of 53 feet and a hold 31 feet deep, with a deadweight tonnage of 8,400 tons. Steam will be supplied to a triple expansion engine by three Scotch boilers; speed, 11 knots.

Ferryboat, New York.—The Board of Estimate has appropriated $600,000 for the construction of a new ferryboat for the Staten Island line, and appropriated $45,000 for the purchase of the ferryboats Steinway and Bowery from the New York East River Ferry Company. Commissioner Whalen, of the Department of Plant and Structures, received $110,000 for the reconstruction of the boats and $16,210 for operating expenses for September.

Freight Steamer, Newburgh, N. Y.—With the recent launching of the 9,000-ton deadweight steel freight steamer, Storm King, the Newburgh Shipyards, Inc., completed its contract with the Shipping Board. The vessel is of the two-deck, poop, bridge and forecastle type, having a bronze propeller driven by a triple expansion engine of 2,000 horsepower, with three Scotch boilers. The vessel is arranged so as to be quickly converted for burning oil if desired.

Ferryboat, Groton, Conn.—Word from Boston is to the effect that the Groton Iron Works, Groton, Conn., a subsidiary of the United States Steamship Company, 50 Church street, New York, has won the contract for building a large steel ferryboat for the city of Boston. Officers of the company say they are daily in receipt of inquiries regarding the building of freighters and tankers. The second is to be built by the Winnisimmet Shipyards, Chelsea, Mass.

Steel for Ship.—Twelve hundred tons of steel to rebuild the steamship Liberty Glo, the vessel built at Hog Island and blown in two by a German mine in the North Sea eight months ago, have been sent to Rotterdam. The Liberty Glo struck the mine on last December 5, more than a year after the armistice was signed. The vessel parted amidships and the ends floated ashore. They were towed to Rotterdam on April 4, this year, and placed in a dry dock there.

Shipbuilding Company Organized, Manitowoc, Wis.—The Manitowoc Shipbuilding Corporation has been organized under the laws of Wisconsin, with an authorized capital of $1,500,000, by A. L. Nash, Lawrence W. Dedvin and E. L. Nash, to do general shipbuilding, dry dock and dockage business. The new corporation is formed by the interests which have acquired the bulk of the property of the Manitowoc Shipbuilding Company, one of the American Shipbuilding Company group which has completed its Government contracts.

Concrete Steamers and Tankers, Jacksonville, Fla.—The Newport Shipbuilding Corporation, Woodward building, Washington, D. C., has applied for a lease of 700 feet of the Bentley shipyard at Jacksonville, and the City Commissioners have set a price of $1,200 a year for the property. The concern is said to have Government contracts for eleven concrete river steamers and three concrete tankers, to cost approximately $5,000,000, and keep 500 or 600 men busy for at least two years. R. H. Arnold is general manager for the company.

Tanker Contracts Delayed.—Delays in the delivery of Scotch marine boilers have prevented the closing of additional contracts for the construction of ships in Pacific Coast yards. The Anglo-Saxon Petroleum Company is said to have vainly tried to place orders for tankers in many yards of the country. The Southwestern Shipbuilding Company and the Union Construction Company declare a report that they have closed contracts for Anglo-Saxon and Vacuum Oil tankers is premature.

To Recondition Steamer, New York.—The steamer Nopatin, purchased by the Hudson River Day Line, is to be reconditioned and her upper works rebuilt along the lines of the Washington Irving of the same line. J. W. Millard & Bro., 17 State street, New York, have plans for the work, and bids have been submitted by the Harlan plant of the Bethlehem Shipbuilding Corporation, Pusey & Jones, and the Bath Iron Works, but it is understood that the award has not yet been made. The steamer is to be renamed the DeWitt Clinton.

Tankers, New York.—Extensive plans for development, calling for expenditures aggregating between $55,000,000 and $60,000,000, have been worked out by the Atlantic, Gulf & West Indies Steamship Company, 11 Broadway. The development contemplated is to spread all over the globe, and includes building tankers in this country, improvement and extension of the company's properties in Mexico, construction of the first French pipe line, between Havre and Paris, and work on properties in England recently acquired by the company. Of the total amount about $35,000,000 will be for new tankers.

Barges, Newburgh, N. Y.—The Tank Steamship Corporation is building oil barges of 11,500 barrels capacity for the Southern Oil & Transport Company. These barges will be built on the transverse system of framing, square ended, raked bow and stem, flat-bottom, square-bilges, straight sides, no shear, deck sloped, deck houses aft, with accommodations for two men. There will be three transverse oil-tight bulkheads and two longitudinal non-oil tight bulkheads, heating coils in each tank, loading through hatches, unloading through a large pump, with 12-inch suction and 10-inch discharge, capacity 2,000 barrels per hour.

Tankers, Camden, N. J.—The New York Shipbuilding Corporation has sold the two 9,820 deadweight tons tank steamers which were to be constructed for builder's account to the United Fruit Company and the Pacific Mail Steamship Company. The first will be delivered on February 1, 1921, to the United Fruit Company, and the second about May 1 to the Pacific Mail Steamship Company. Keels for two additional tankers for builder's account and to be sold later will be laid this fall. The company is also building nine of the 18-knot type and seven of the 14½-knot speed for the Government. It is announced that the American Line will also place a contract with the company for a number of liners having a registry of about 20,000 tons.

SHIPYARDS AND DRY DOCKS

Repair Plant Equipment, Mobile, Ala.—P. N. Auger, architect of the Kelly Dry Dock & Shipbuilding Company, has plans and specifications for improving the plant and for shop equipment, which call for the expenditure of about $150,000.

Dry Dock, Chester, Pa.—The Sun Shipbuilding Company is building a floating dry dock of 10,000 tons capacity, with wooden pontoons and continuous steel wings, from designs by William T. Donnelly, 17 Battery Place, New York. The dock will be 523 feet 6 inches long on the keel blocks, with an overall width of 110 feet.

New Dry Docks, Brooklyn, N. Y.—The Ramberg Dry Dock & Repair Company, Inc., plan improvements, including two new steel floating dry docks to lift cargo vessels of 10,000 and 14,000 tons. The power plant, foundry, machine shops, boiler shops, pattern and carpenter shops and store rooms will be enlarged, and improved machinery added to the plant.

Temporary Shut-Down, Pascagoula, Miss.—The International Shipbuilding Company, which has been running on Italian contracts, has been forced to shut down owing to the Italian exchange situation. It is expected to resume as soon as the money market is straightened out. Three steel ships are in the wet basin awaiting completion, one being due in October.

May Buy Pusey & Jones Yard, Gloucester, N. J.—The Bethlehem Shipbuilding Corporation is negotiating for the purchase of the Pusey & Jones plant. No papers have been signed, but an agreement has been reached as to the sale in case the present owners are able to reach a financial settlement with the Emergency Fleet Corporation and thus obtain a clear title to the plant.

Dry Dock.—The 8,000-ton floating dry dock which is being designed by Mr. William T. Donnelly for the Federal Ship Building Plant of the United States Steel Corporation, will have nine wooden pontoons, continuous steel wings extending the entire length, length over keel blocks 438 feet, length over the wings 377 feet, and a clear width between wings of 84 feet, and will take a draft of 22 feet over 4-foot keel blocks. There will be two centrifugal pumps in each pontoon, electrically operated. From a 440-volt, 3-phase, 60-cycle alternating current.

Shipyard Expansion, Milwaukee, Wis.—The Milwaukee Dry Dock Company, a member of the American Shipbuilding Company group, has an improvement programme involving an investment of $1,250,000. A new dry dock capable of accommodating Great Lakes vessels up to 625 feet will be constructed early in the fall or next spring. Work has started on a new pump house costing $75,000 with equipment and a new office building. Later additional machine shops and auxiliary buildings will be erected. F. W. Smith is secretary-treasurer and general manager.

Shipyard Improvement, Quincy, Mass.—The old cranes and runways serving submarine slips Nos. 1, 2, 3 and 4, Bethlehem Shipbuilding Corporation, Fore River, are being moved to make room for the erection of eleven new towers with the necessary runways and the placing of two new 120-foot span cranes. These cranes will have the same height as those on adjoining slips—110½ feet above mean low water. They are to be used in connection with the company's new slip No. 4, which has a concrete keelway 512 feet long, designed for vessels of a maximum length of 520 feet and 75 feet beam, and have a clear width between towers of 108 feet.

SHIPPING DEVELOPMENTS

Steamship Line, Hayti.—The Republic of Hayti is to have a steamship line with native capital, principally for the export of sugar.

New Shipping Company, Newport News, Va.—The Atlantic Ship Service Corporation has been chartered at $25,000. H. H. Lackey is secretary and treasurer.

Steamer Sale Canceled.—Sale of five steamers to the Green Star Steamship Company has been canceled, and the ships have been assigned to the company under a managing agency agreement.

New Line to Antwerp.—The Lloyd Royal Belge Steamship Company established a passenger service between New Orleans, La., and Antwerp recently with the sailing of the 8,400-ton steamer Olympier.

Shipping Merger, English Lines.—It is reported from London, England, that the Union Steamship Company of New Zealand, the British India, and the Peninsula & Oriental Lines have merged.

Mobile Service Continued.—The Mallory Line service between New York and Mobile is not to be discontinued, as the company has arranged for the use of the Baltimore & Ohio Railroad Company's piers until October 1.

Extending French Service.—The Barber Steamship Company is planning extensions of importance in its French-Atlantic freight services. The concern has been active in the French steamship business for more than forty years.

Bremen-New Orleans Service.—The J. H. W. Steele Steamship Company plans to develop the former North German Lloyd trade routes between Bremen and New Orleans and other Gulf ports, as well as to Cuba and and Mexico.

Steam Schooner Line.—With the General Steamship Corporation as Puget Sound agent, the new steam schooner line to be known as the Coastwise Steamship Company will soon inaugurate service between North Pacific points and San Francisco.

Steamer Sold, Baltimore, Md.—The States Steamship Company has bought the Shipping Board wooden steamer Clio, 3,500 deadweight tons, for $175,000. The Clio was built by the Pacific American Fisheries Company, at Bellingham, Wash., in 1919.

Service to Australia.—Regular American steamship service between New York and Australia is expected to follow the sailing on September 10 of the British ship Fuitala, owned by the British India Line, but under charter to the American Steamship Line.

New Steamship Line, Baltimore, Md.—The Lone Star Oil Transport Company, Calvert building, Baltimore, Md., has been incorporated by James L. Watson, Ferdinand H. Butehorn and Thos. E. Hale, with a capital of $500,000, to operate steamships, barges, etc.

Begins German Service, New York.—The United States Mail Steamship Company's service between New York, Bremen and Danzig was begun on August 4 with the sailing of the steamer Susquehanna, Capt. George Dundas, with a full second cabin list and 500 third class passengers.

North Pacific Norway Service.—A direct steamship service between Puget Sound and the ports of Norway has been planned for the immediate future. While the products of the Northwest have been shipped to Norwegian ports for some time, they have been sent via the Atlantic seaboard.

Line to Far East.—The J. H. W. Steele Company plans a monthly service between New Orleans and the Far East, to begin with the steamer Canada Maru. The company is agent for the Osaka Shosen Kaisha. It is said that the fare to Yokohama will be $294 for cabin and $120 for steerage passage.

Package Service, New York.—The New York & Western Canal Line, Inc., has established a package service from Pier 6, East River, to Syracuse and Rochester. The boat Fred W. Barth has started the service from Rochester and the Willis B. Knapp from Syracuse. Maltus & Ware are the general managers.

New Shipping Company, Memphis, Tenn.—A shipping company, capitalized at $1,000,000, is being formed to fight the proposed order of the Interstate Commerce Commission placing Memphis freight rates on the "dry land" basis, and a fund of $75,000 is to be used to secure options on boats for use on the Mississippi River. It is proposed to operate boats between Memphis, New Orleans and St. Louis.

Holland's Shipping Service.—The Associated Dutch Shipping Company established a new line to Australia, to be known as the Holland-Australia Line. The Holland-America Line will open a joint service with the Royal Mail Steam Packet Company to North Pacific ports, and the Royal Dutch Steamboat Company is inaugurating regular sailings to Braila and Galatz. The Royal Dutch Lloyd has joined the Holland-South Africa Line.

To Raise Coastwise Rates. — Coastwise steamship lines expect to put new tariffs into operation by September 1, in accordance with the permission granted by the Interstate Commerce Commission to raise their rates as much as the railroads. Generally, it is understood, the rates will not be increased more than 25 percent, but some executives of coastwise lines are not sure about that advance being enough to allow them to operate at a profit.

Steamers Sold, Charleston, S. C.—The steamship Lehigh, which has been managed and operated by the Carolina Company for several months, was sold by the Shipping Board. The Cape Henry, another Shipping Board steamship, has been bought outright by the Atlantic, Gulf & Pacific Company. Both vessels are now at Charleston, S. C., awaiting delivery to their new owners. The steamer Marica, of 12,000 deadweight tons, has also been sold by the Shipping Board to the Luckenbach Steamship Company, New York.

Freight Service, Richmond, Va.—Harriss, Magill & Company, 35 South William street, New York, announce the formation of the Richmond-New York Steamship Company, of which they are managers. Two vessels, the Lake Frances and Lake Sterling, have been purchased from the Shipping Board, and will be used for a regular freight service between New York and Richmond and City Point, Va., the latter to serve Hopewell and Petersburg. Other vessels will soon be added. The company has purchased the terminal formerly occupied by the Old Dominion Line at Richmond, and has New York offices at 24 South William street.

Freighters Sold.—Two of the Skinner & Eddy freighters, the Robin Adair and the Robin Hood, have been sold by D. E. Skinner, president of the building company and head of the Robin Line, for $3,000,000, or a fraction of over $144 per deadweight ton, to the United States Steel Corporation. The ships were built at Seattle and are only a few months old. They are oil burners, equipped with geared turbine engines and can make a speed of 11 knots. They may be converted into coal burners in three hours' time, and are considered the best type of cargo carriers. The freighters at $144 per deadweight ton is considered significant, in that ships of American registry, constructed by a recognized builder, are below $150 per deadweight ton.

PORT IMPROVEMENTS

Wharves, Helena, Ark.—The municipality will construct wharves on the Mississippi River front. Address the Mayor.

Dock, Yonkers, N. Y.—Contract for a city dock at the foot of Main street has been let to G. W. Rogers, 29 Broadway, New York City; cost, $150,000.

Wharf, Norfolk, Va.—Hastings Wharf & Terminal Corporation chartered; capital, $100,000. G. T. Hastings is president and W. B. Hastings is secretary.

Municipal Dock, Pensacola, Fla.—The City Commission is having plans prepared for a municipal dock and a belt-line railway; a $400,000 bond issue has been voted for the purpose.

Dock and Sheds, Milwaukee, Wis.—The Rockwell Manufacturing Company, 582 Park street, has drawn plans for the construction of a concrete dock and lumber sheds at Sixth street, Milwaukee.

Docks, Piers, Etc., Baltimore, Md.—The city votes on November 2 on a $10,000,000 bond proposition to provide for docks, piers, warehouses, etc.; H. G. Peering, City Hall, in charge as engineer.

Crane, Humboldt, Cal.—Specifications are being worked out for a 20-ton narrow gauge locomotive crane for use in shore protection work at Humboldt, Cal., by George F. Whittemore, engineer in charge.

Piers, Toledo, Ohio.—The municipality will purchase the wharves of one of the lake navigation companies as the first step in a programme calling for development of an extensive municipal pier system.

Bulkhead and Dock, Bridgeport, Conn.—Contract for a 250-foot bulkhead and 200-foot dock on wood pile foundation has been let to J. Pardy Construction Company, 1481 Seaview avenue; about $60,000.

Pier, Seattle, Wash.—The Great Northern Railroad, 712 Second street, let contract for rebuilding Smith Cove pier, 600 feet long and 122 feet wide, to J. A. McEachern Company, Colman building; about $75,000.

Bulkhead, Piers, Etc., Chester, Pa.—The Sun Shipbuilding Company has let a contract for bulkhead, piers and dredging to J. E. Brenneman, North American building, Philadelphia, to cost about $500,000.

Wharf, Seattle, Wash.—The Grant Smith Construction Company will build a wharf 1,000 feet long and warehouse at the plant of the Fisher Flouring Mill Company, on Harbor Island, Seattle; cost, about $250,000.

Docks, Tampa, Fla.—The Denton-Shore Lumber Company, Philip Shore, president, will improve export docks and secure additional 600 feet frontage, and probably will duplicate its 60,000 feet capacity resaw plant.

Pier, Everett, Mass.—Contract for a pier, approach and foundation, of reinforced concrete, for Merrimac Chemical Company, 148 State street, Boston, has been let to Aberthaw Construction Company, 27 School street, Boston.

Dredging.—Bids are to be asked for about 480,000 cubic yards of floating dredge work, and about 300,000 cubic yards of laterals in the Laban Bayou district, Mississippi. W. W. Boone, civil engineer, Cleveland, Miss., has details.

Wharf, New Orleans, La.—Port Commissioners, 200 New Orleans Court building, will improve First Street Wharf; concrete floors, chain walls, paving, earth fill, etc.; 170,000 square feet, $200,000. Arsene Perrilliat, chief engineer.

Dock, Tacoma, Wash.—Surveys have been made by the Puget Sound Navigation Company for the erection of a dock and waiting room for the passenger steamers of the company here, made necessary by the increased rental demanded for the municipal dock.

Dredging.—Twelve miles of floating dredge work, involving 350,000 cubic yards of excavation, and 12 miles of laterals involving about 150,000 cubic yards of excavation, are to be undertaken in Bolivar County, Miss. W. W. Boone, civil engineer, Cleveland, Miss., has details.

Ocean Terminal.—Involving property valued at nearly $2,000,000, the First National Bank of San Francisco has acquired the controlling ownership in the East Waterway Dock & Warehouse Company and its ocean terminal on Harbor Island, Wash., and will make improvements.

Coal Terminal, Mobile, Ala.—A site for a coal terminal has been selected here, and will be recommended to Gen. W. D. Connor, head of the Inland Waterways Division of the War Department, together with designs, estimates, etc., and if approved a contract will be let for building the terminal.

Terminal, Tampa, Fla.—The Port Commission has been authorized to expend more than $500,000, and the engineers have plans ready for the first unit, to be built around a single slip running from the main ship channel about 825 feet back to a six-story warehouse, with loading platform, railroad tracks, etc.

Oil Storage Tanks.—Negotiations have been opened with the Shipping Board with a view to having some of the forty wooden hulls now lying in Lake Union, Seattle, Wash., converted into oil storage tanks at a cost not exceeding $40,000 each. In the Far East and other parts of the world there is an acute shortage of oil storage facilities.

Pier.—The Camden, N. J., Harbor Commission awarded a contract for the construction of a concrete pier on which will be built a $500,000 marine terminal at Spruce street to the Tilt-Hargan Company, 90 Broadway, New York, on a bid of $201,799. The pier will be 472 feet long and 102 feet wide. Construction is to start at once, and plans are being drawn for the terminal.

Terminal, Natchez, Miss.—H. McL. Harding, consulting engineer, is investigating conditions of Natchez harbor and making plans for river terminals. The Natchez Chamber of Commerce has communicated with the ship corporation formed at Memphis for the purpose of operating boats between Memphis and St. Louis and Memphis and New Orleans for information regarding the proposed lines.

Wharf, New Orleans, La.—Plans of the Dock Board include the building of a modern wharf on the west bank of the Mississippi for the Crescent Industrial Alcohol Company, to be equipped with pipe lines for loading vessels, and the installation of mechanical banana conveyors for the Cuyamel Fruit Company. Another item is the investment of $200,000 in making the First street wharf ratproof. The wharf is 1,800 feet long.

Terminal.—E. S. Walsh, superintendent of Public Works, Albany, N. Y., will receive bids until September 9, 1920, for building portions of dock wall around Ohio Basin, Buffalo, N. Y., contract 53-A; estimate, $426,000; also storage yards at Erie Basin, contract 76; also furnishing and installing jib cranes at Barge Canal terminal at Erie Basin, contract 114; also contract 26-A, for completing Barge Canal terminal at Rouse's Point, N. Y.; estimate, $26,000.

Bay Improvements, Newark, N. J.—Finance Commissioner J. F. Gannon, Jr., has been authorized by the Jersey City Commissioners to provide $650,000 for the improvement of Newark Bay and Hackensack River front from Droyer's Point to West Newark avenue, according to plans of Commissioner A. H. Moore and the Jersey City Board of Engineers. The plans call for extensive bulkhead work and the reclaiming of 85 acres of land.

Piers and Equipment, Philadelphia, Pa.—Hoisting, loading, conveying and other machinery for general freight service will be installed on piers and docks to be constructed by the Department of Wharves, Docks and Ferries. An ordinance has been approved by Mayor Moore authorizing the building of three double-deck piers, 160 by 530 feet, and 80 by 556 feet, respectively, with intervening docks about 170 feet long. The structures will be on the Delaware River, and are estimated to cost about $500,000, including equipment.

GOVERNMENT BUSINESS

Jetty, Jacksonville, Fla.—United States Engineer Office will receive bids until September 15, 1920, for building jetty at entrance to St. Johns River.

Dredging, Wilmington, Del.—United States Engineer Office rejected bids received July 15 for dredging waterway between Rehoboth and Delaware Bays.

Classified Advertisements will be found on Pages 162 and 163 of the Advertising Section

Dry Dock, Charleston, S. C.—Work is to begin soon on the navy dry dock here. Cost estimated $4,000,000. Commander G. S. Burrell, U. S. N., is in charge.

Dredging, New Orleans, La.—United States Engineer Office, Custom House, rejects only bid received July 30 for dredging Calcasieu Section Intracoastal Waterway, etc.

Barges, Nashville, Tenn.—United States Engineer Office will receive sealed proposals for four steel barges until 11 A. M., September 13, 1920. Further information on application.

Bulkhead and Wharves, Tampa, Fla.—United States Engineer Office, War Department, Washington, D. C., let contract for building bulkhead and wharves here to J. R. Chambliss, Tampa; $5,335.

Sale of Material.—The Shipping Board will receive bids until 11 A. M., September 16, for the machinery, equipment and materials at the yard of the National Shipbuilding & Dry Dock Company, Savannah, Ga.

Hog Island Yard to Be Sold.—The Shipping Board is offering the Government-owned shipyard at Hog Island for sale, and bids will be received by the Supply and Sales Division, United States Shipping Board, until 5 P. M., October 30.

Jetty, New Orleans, La.—United States Engineer Office, Custom House, will receive sealed proposals until 11 A. M., September 16, 1920, for extending jetties at the mouth of the Southwest Pass of the Mississippi River.

Repairing Wharf and Slips.—Specification 4260. The Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for repairing Wharf 3 and Slips 2 and 3; $10 deposit required for plans and specifications.

To Sell Concrete Tankers.—Two concrete tankers are offered for sale by the Shipping Board. They are of 7,500 deadweight tons each, with an estimated speed of 10½ knots. The vessels are being built at Oakland, Cal., are named the Palo Alto and Peralta.

Structural Steel Castings, Louisville, Ky.—United States Engineer Office will receive sealed proposals for furnishing and delivering structural steel castings, etc., for Lock No. 44, Ohio River, until 12 o'clock noon, central time, September 9, 1920. Information on application.

Harbor Development, Great Lakes, Ill.—Specification 4136, Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids for developing harbor, to include dredging and filling, building breakwater, pier, quay walls, etc.; $10 deposit required for plans and specifications.

Barges, Gulfport, Miss.—The Gulfport Shipbuilding Company has received a contract from the United States Government for six barges to be constructed at the local yards, three of which will be 72 feet and the other three 61 feet in length. They will be fitted with high powered engines, and will be used for coastwise and inland waterways service.

Submarine Chasers to Be Sold, Washington, D. C.—The sale of 141 submarine chasers has been authorized by Secretary of the Navy Daniels. The suggestion is they may be converted into yachts, fishing boats, fireboats, police boats, and even small freighters. The Board of Survey, Appraisal and Sale, Navy Department, Washington, D. C., has charge of the sale.

Submarines.—Bids were opened August 18 by Secretary Daniels for the construction by contract of six of the nine fleet submarines which are authorized by the Naval Appropriation Bill of August 29, 1916. The other three are now under construction at the navy yard at Portsmouth, N. H. The lowest bid was by the Bethlehem Shipbuilding Corporation, with an offer of $3,900,000 each for the six, deliveries to start in thirty months. Other bidders were the Electric Boat Company and the Lake Torpedo Boat Company. The latter made a cost plus bid.

Tugs Bought.—Six of the bids made for twenty-five tugs have been accepted by the Shipping Board. The others were rejected because of unsatisfactory terms. The Cahill Towing Company, of New York, obtained the Artesan and Woodman at $83,000 each, having raised their original bids. The Pringle Barge Line Company, of Cleveland, obtained the Custodian for $83,000; the Standard Oil Company, of Indiana, the Outagamie for $200,000; Thomas J. Howard, of New York, the Toilers for $72,000, and the M. J. Dady Engineering & Contracting Company, of Brooklyn, the Craftsman for $83,000.

To Build Biggest Battleship.—Before the end of the year the United States Government will start construction on the world's largest, most powerful and fastest warship, the Lexington, at the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., Quincy, Mass. Eight 16-inch guns will comprise the main battery, with numerous smaller guns. The boat will have a speed of 35 knots, obtained by use of armor plate only 5 inches in thickness, but of greater strength than any armor belt now in use. In the words of her designers the Lexington will be a "whale of a boat." Her length overall will be 784 feet, beam 101 feet, and she will displace 43,200 tons. Her power will be electricity, 180,000 horsepower in all. She will be larger and four knots faster than the British battleship Hood, now building.

Marine Engineering

Volume XXV OCTOBER, 1920 Number 10

Chicago Marine Exposition

Marine Week October 18 to 23

Under the auspices of the National Marine League

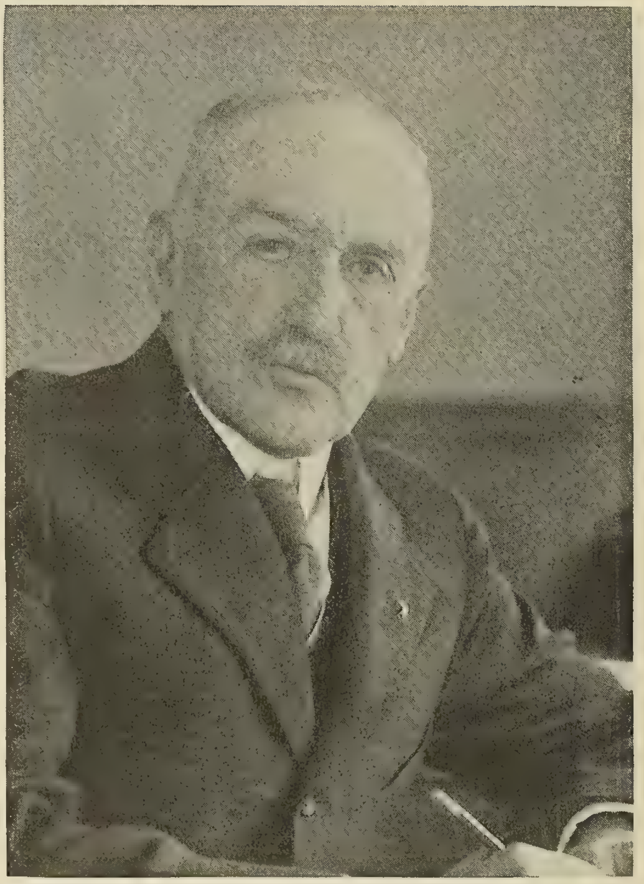
(Photograph copyright by Underwood & Underwood, N. Y.)

NATIONAL MARINE WEEK, which begins on October 18, and the Marine Exposition, which will be held at the Coliseum in Chicago during that week under the auspices of the National Marine League, will be primarily educational in character, a tangible proof to the people of the Middle West that the United States has developed a great shipping industry in which they have an interest and a share. As one looks back on the New York Exposition held last April, its outstanding feature is the interest which the general public took in the exhibits, despite their technical nature. The aisles were packed with men whose conception of the merchant marine was derived from Dana's "Two Years Before the Mast," and whose first-hand acquaintance with ships was confined to ferryboats and excursion steamers. You saw these same men examining the intricacies of a telemotor, bending over a reduction gear, absorbed in a map of the new steamship lanes followed by American shipping, and they left the Exposition with a truer perspective as to what the merchant marine is, and of the necessity for fostering it at the present time. The impression on the public was so pronounced as to lead many exhibitors to request that the Exposition be repeated in the Middle West, to demonstrate to the public there just what the merchant marine is, and to show them that they will benefit as immediately by its success as the people living along the Eastern and Pacific seaboards.

It is obvious that the merchant marine must secure the support of the Middle West, as the seaboard states cannot support such a great organization alone, and it is equally plain that any improvement in transportation and

> Our efforts in behalf of awakening interest in maritime affairs in the Middle West through the medium of the Chicago Marine Show and the Marine Week are meeting with most encouraging success. This affair promises to be the biggest thing of its kind ever held in the country, and with the support that now seems assured there will be no limit to the beneficial results that will follow our joint efforts to arouse enthusiasm in the American merchant marine. The people of America, by the evidence at hand, are more ship-minded than they ever were in the history of the country.—*P. H. W. Ross, president, The National Marine League.*

P. H. W. Ross, President, The National Marine League



Rear Admiral W. S. Benson, Chairman of the Shipping Board

the marketing of goods benefits Indiana as directly as New York. Only, the Middle West has always looked solely to the railroads and needs to be shown that shipping can supplement railroad service, if given an opportunity. A marine show is the most direct and personal method of demonstrating this. It is particularly effective at this time owing to the growth of Great Lakes shipping and the increasing interest in the Middle West over the proposition to link the Great Lakes directly with the ocean, which would virtually make Chicago, Buffalo, Cleveland and other Lake cities seaports.

In a recent pronouncement, Herbert Hoover said:

"We need a national study and a national programme of transportation development, co-ordinating both rail and water, and such a programme will not only embrace the improvement of our interior waterways but will unquestionably call for the improvement of the St. Lawrence route.

"That the ports on the Great Lakes can be put effectively on seaboard with a comparatively moderate expenditure is unquestioned, and that such an accomplishment will enormously improve the prosperity of fifteen states, decrease the cost of distribution of commodities, increase the returns to the producer, require no proof."

The Exposition at Chicago will be a "national study" of the programme of water transportation. It has been enthusiastically endorsed by Admiral W. S. Benson, chairman of the United States Shipping Board, who says in a recent letter to P. H. W. Ross, president of the National Marine League:

"Your letter stating that the Marine Exposition known as the Chicago Marine Show is meeting with most encouraging success reached me today. Marine Week to be inaugurated during the week of this Exposition—October 18 to October 23—will have a splendid effect in my judgment.

"Americans are now awake to the need of loyal support for our merchant marine. We have the ships—we have the opportunity to promote the peace of the world by the development of our commerce, making proper use of these ships in doing so. It is the desire of the Shipping Board to cooperate with all organizations which aim to build up the efficiency and services of our merchant marine.

"It is a pleasure to know that in the work your organization did for the Marine Exposition in New York City the people of the Metropolis were awakened to the opportunity now offered as a result of the merchant marine we now have. Surely the men and women of the Middle West and the Mississippi Valley are as vitally interested in the proper development of this merchant marine as seaboard cities and states.

"I am indeed gratified to learn that the Chicago Marine Show to be held in October is fast approaching a stage which

National Marine Week, which has been arranged to take place in Chicago on October 18 to 23 inclusive, is giving a new impetus to the deep waterways movement in the Middle West. In deciding on Chicago as the Exposition city, the National Marine League has recognized its growing importance as a shipping port. With the future development of the Mississippi River and its tributaries, officials of the League predict a new commercial era for Chicago, her sister lake cities, and the Middle West in general. The attention of the people in these sections will be focused on the increasing importance of America's merchant sea power in relation to the maintenance of inland prosperity. Also the public of the entire nation will be awakened to the wealth and magnitude of lake and inland water shipping, to the end that this part of the nation's transportation problem may receive the serious attention of the various state legislatures and of Congress.

promises, together with Marine Week, 'to be the biggest thing of its kind ever held in the country.' I agree with you that there will be no limit to the results that will follow our joint efforts to arouse enthusiastic interest in the American merchant marine.

"The Shipping Board is now at work on its exhibit for Chicago. It is our aim to co-operate with you in every way possible to make the Chicago Marine Exposition a striking success."

Admiral Benson will formally open the Chicago show and is expected to preside at the banquet to be given by the League at the Congress Hotel on October 19 as the culmination of the proceedings of Marine Week, which will last during the period of the Exposition and consists of lectures, displays and moving pictures, and meetings of prominent Chicago business men with those interested in shipping and port development.

It is natural in view of the predominantly educational character of the Chicago show that the steamship lines should be well represented. In addition to the Shipping Board, which will display the largest map ever constructed, the International Mercantile Marine, the Luckenback Steamship Company, the Munson Line, the Pacific Mail Steamship Company, and the Oriental Navigation Company will install displays.

Among the exhibitors at the Marine Exposition will be the following:

United States Shipping Board.
International Mercantile Marine.
American Car & Foundry Company.
W. & J. Tiebout Company.
Simmons-Boardman Company.
Irving Iron Works.
Pneumercator Company.
Wailes, Dove, Hermiston Company.
New York Engineering Company.
American Bureau of Shipping.
Luckenback Steamship Company.
New Process Chemical Company.
American Library Association.
New York Marine News.
Consolidated Shipbuilding Company.
The Crane Company.
The McNab Company.
Hanlon-Gregory Galvanizing Company.
Kroeschell Bros. Ice Machine Company.
Aluminum Cooking Utensil Company.
Albert Kingsbury, Engineer.
Munson Steamship Company.
American Steel Foundries.
Maritime Hydraulic Oil Service.
Lunkenheimer Company.
D. T. Williams Company.
Valentine & Company.
Geo. B. Carpenter Company.
Fairbanks, Morse & Company.
The Submarine Boat Corporation.
The United States Rubber Company.
The General Electric Company.
Chas. A . Durkee Company.
American Chain Company.
Pacific Mail Steamship Company.
All America Cables Company, Inc.
Ferguson Lange Foundry Company.
United States Public Health Service.
Pyle-Watt National Company.
White Fuel Oil Engineering Company.
The Texas Company.
Benjamin Electric Company.
Oriental Navigation Company.
Penton Publishing Company.
John A. Roebling Company.
Hubbard H. Erickson Company.

Norwegian Vessel Built in England

ONE of the vessels recently accepted by foreign owners from British yards is the cargo vessel *Horda* built by Messrs. William Gray & Company (1918), Ltd., West Hartlepool, for J. Ludwig Mowinckel, of Bergen, Norway.

The principal dimensions of the vessel are:

Length overall	391 feet 9 inches
Beam, molded	53 feet 6 inches
Depth, molded	26 feet 3 inches
Deadweight cargo carrying capacity	7,500 tons

The propelling machinery, fabricated at the Central Marine Engine Works of the builders, consists of a triple expansion engine having cylinder diameters of 25 inches, 41 inches and 68 inches, and a stroke of 48 inches. Steam is supplied at 180 pounds per square inch by three Scotch boilers 16 feet in diameter and 11 feet long. The boilers are equipped to burn fuel oil.

The auxiliaries include two independent feed pumps, a centrifugal pump, a general service pump, an auxiliary feed pump, a ballast pump, a condenser with combined air and circulating pumps, an oil trimming pump and an evaporator.

Cargo Steamship *Horda*, of 7,500 Tons Deadweight Carrying Capacity

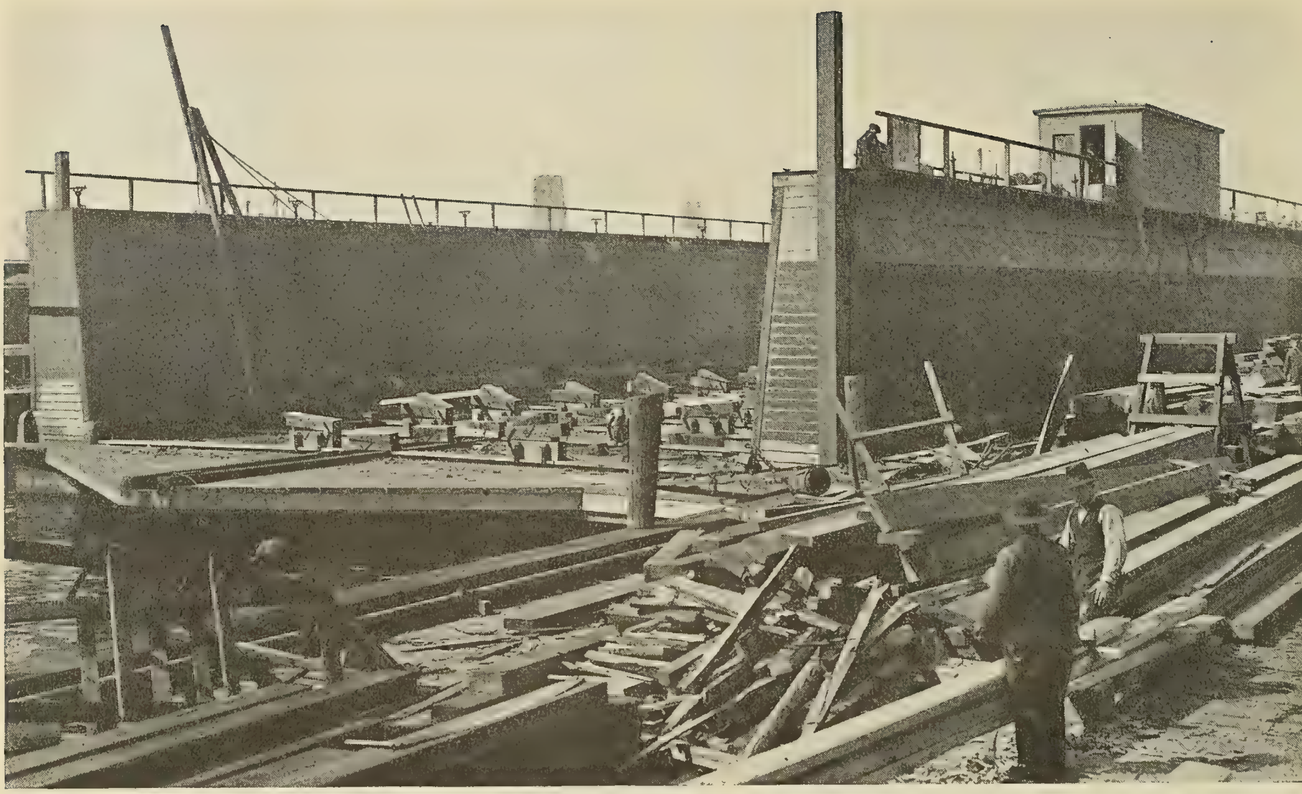


Fig. 1.—2,400-Ton Dock of Vulcan Iron Works, Under Construction

Motors for Operating Floating Dry Docks

BY WILLIAM H. EASTON*

As in all other branches of ocean shipping, America has heretofore lagged behind Europe in the construction of dry docks. From the time of the Civil War until the end of the last century, not a single commercial dry dock of importance was built in the United States, and though a number have been put into service during the past twenty years, the war caught us with utterly inadequate docking facilities. As an inevitable result of our recent shipbuilding activities, which have left us in possession of a vast fleet of merchant vessels, numerous dry docks are now either under construction or projected in many of our more important ports. It is important, therefore, that the motive power for the operation of these docks be given careful consideration.

THE new docks now being built in American harbors will be mainly, if not exclusively, of the floating type. The graving dock has, generally speaking, the advantage of a somewhat more rigid floor, but its first cost is greater, it requires more time to construct, it is more expensive to operate, is less flexible in service, and, since it must lie below water level, working conditions in it are not altogether satisfactory. Hence the floating dock, especially after the completion of the 20,000-ton floating dock *Dewey,* and its spectacular voyage to the Philippines, has generally taken the place of the older form.

Alternating Current Motors Preferred

Though the design of a successful floating dry dock presents an engineering problem of the highest order, its equipment of machinery is very simple, consisting only of pumps and valves and the means for operating them. In the older docks the pumps were driven by steam engines, but today electric motors are invariably used, unless it is impossible to obtain electric current. The valves are always hand operated.

A motor for a dry dock pump must be very strong mechanically and be thoroughly insulated and protected against dampness. The earlier motors were mainly of the single speed type, but the present tendency is to employ variable speed motors so that the dock master can control the rate of the rise of the dock by varying the speed of the pumps as well as by manipulating the valves. The alternating current, variable speed, wound rotor motor is ideal for the service and is generally used, though the squirrel cage motor is suitable where speed variation is not desired. Direct current motors can be employed, if nothing but direct current is available, but alternating current is always to be preferred because of the greater simplicity of the alternating current motor and the economy with which this form of current can be transmitted long distances.

There are several different methods of driving the pumps by means of motors, and these are well illustrated by certain docks in New York Harbor.

Vulcan Dock

The simplest type of drive is that used on a new 2,400-ton section of a dock of the Vulcan Iron Works at Jersey City, N. J. This dock is 140 feet long, has a beam of 80 feet, and wings 30 feet high. There are 24 plunger type

* Westinghouse Electric & Manufacturing Company.

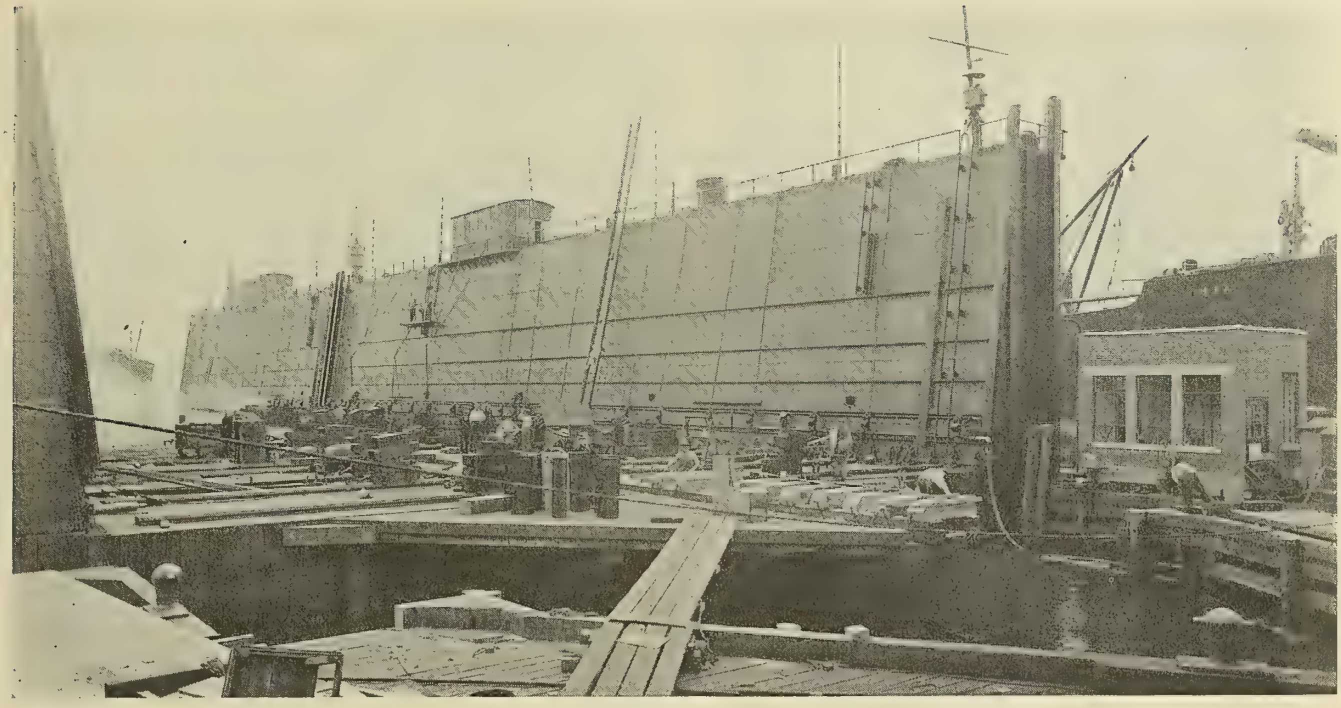


Fig. 2.—10,000-Ton Dock of W. & A. Fletcher Company. Control House at the Right

pumps, each with a cross-section of 12 by 12 inches and a 22-inch stroke, all of which are placed in one wing, and are driven by a line shaft that runs along the deck of the wing. A 125-horsepower Westinghouse motor, located in a house on the deck, is geared to the line shaft and drives all of the pumps.

This motor is of the alternating current, wound rotor type and operates on a 220-volt circuit. It is controlled by a manually operated drum type controller, also located in the house, and its speed can be varied over a range of from 250 to 500 revolutions per minute, which gives line shaft speeds of from 55 to 110 revolutions per minute. The gears are of bronze and all of the mechanical work is of the most rugged character. The motor mounting is made especially rigid by enclosing the gear end bearing housing of the motor in a box that is firmly bolted to the foundation. An oil pipe, to supply oil to the motor bearing, passes through the box.

This form of drive and control, which closely follows earlier steam drive practice, is probably the most economical and satisfactory for small docks.

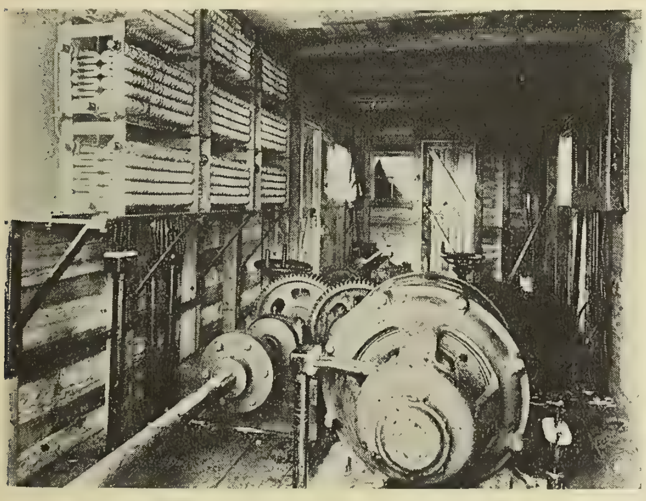


Fig. 3.—125-Horsepower Westinghouse Motor Driving 24 Pumps on Vulcan Dock. Controller in Right-Hand Corner

A somewhat similar drive, but a very different method of control, is found on the new 10,000-ton steel dock of the W. & A. Fletcher Company at Hoboken, N. J. This dock, which is 435 feet long and has a beam of 110 feet and wings 35 feet high, is built in two sections, one of which consists of 4 pontoons and the other of 5.

The Fletcher Dock

It has eighteen 12-inch centrifugal pumps, with a rated capacity of 2,200 gallons per minute each and a maximum speed of 500 revolutions per minute, which are mounted in all four wings and are driven by line shafts, as in the Vulcan dock, five pumps being driven by a 200-horsepower motor on each of the larger wings, and four pumps by a 125-horsepower motor on each of the smaller wings. The motors are of the Westinghouse variable speed, wound rotor type and are located in houses near the centers of the wings. The shaft of each motor is doubly extended, and each end is geared to a section of the line shafting.

The most unusual feature of these motors is that they operate on a 2,400-volt circuit and are probably the first high voltage motors to be used on a dry dock. Ordinarily high voltage current as received from a central station is reduced to 220 or 440 volts for use around the dock, but in the case of the Fletcher dock the high voltage lines are led directly to the motors, and thus the expense of large step-down transformers is eliminated. Naturally the greatest care has been exercised to insure the thorough insulation of the high voltage cables (which are run along the back of the wings out of the reach of the ordinary workmen), and everyone is excluded from the motor houses when the current is on.

Control System

The control for these motors is centered in a small brick house located on the pier at the end of the dock. A panel in this house carries four small drum type master controllers, one for each motor. A single operator can start, stop, speed up and slow down any or all of the motors as the dock master directs. The master controllers do not directly control the motors but control the operation of magnet switches which are mounted on panels beside each

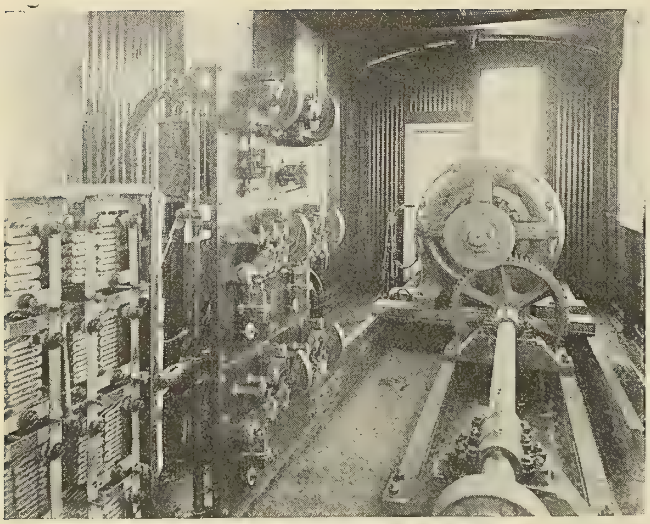


Fig. 4.—200-Horsepower 2,400-Volt Westinghouse Motor Driving Pumps on Fletcher Dock. Magnet Switch Controller at the Left

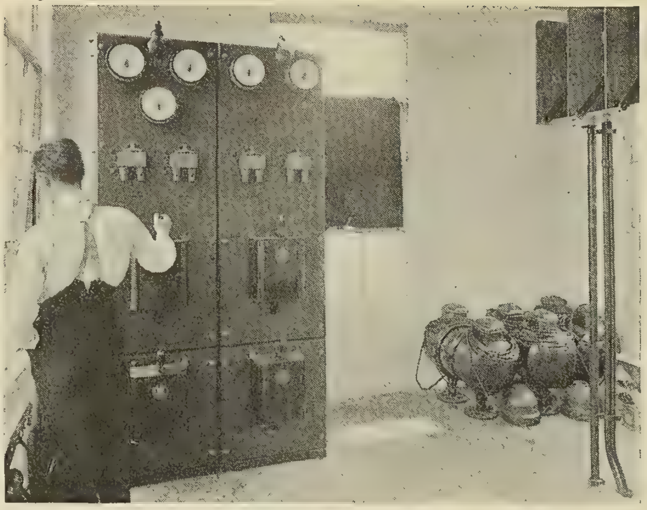


Fig. 5.—Master Controllers of the Fletcher Dock Motors

motor. Movement of the handle of a master controller causes certain of the switches on the proper control panel to close or open and thus make the desired motor connections. The master controllers do not, therefore, handle the large, high voltage currents used by the motors, but only small low voltage auxiliary currents, so that the wiring is inexpensive and the controllers are perfectly safe to handle. The master controller panel also carries an ammeter for each motor, which gives the operator exact information as to the motor's performance. In the control house are also located the high voltage cut-out switches, by means of which any desired circuit on the dock can be rendered dead.

Robins Dock

A very different type of drive is in use on the large 24,000-ton dock of the Robins Dry Dock & Repair Company, Brooklyn, N. Y., which was built in 1913. This dock consists of six sections, each 80 feet long and 130 feet wide, and each section has two 20-inch vertical shaft centrifugal pumps (one in each wing) driven by a 100-horsepower, 440-volt vertical motor directly connected to the pump shaft. The motors are of the alternating current Westinghouse squirrel cage type and operate at a constant

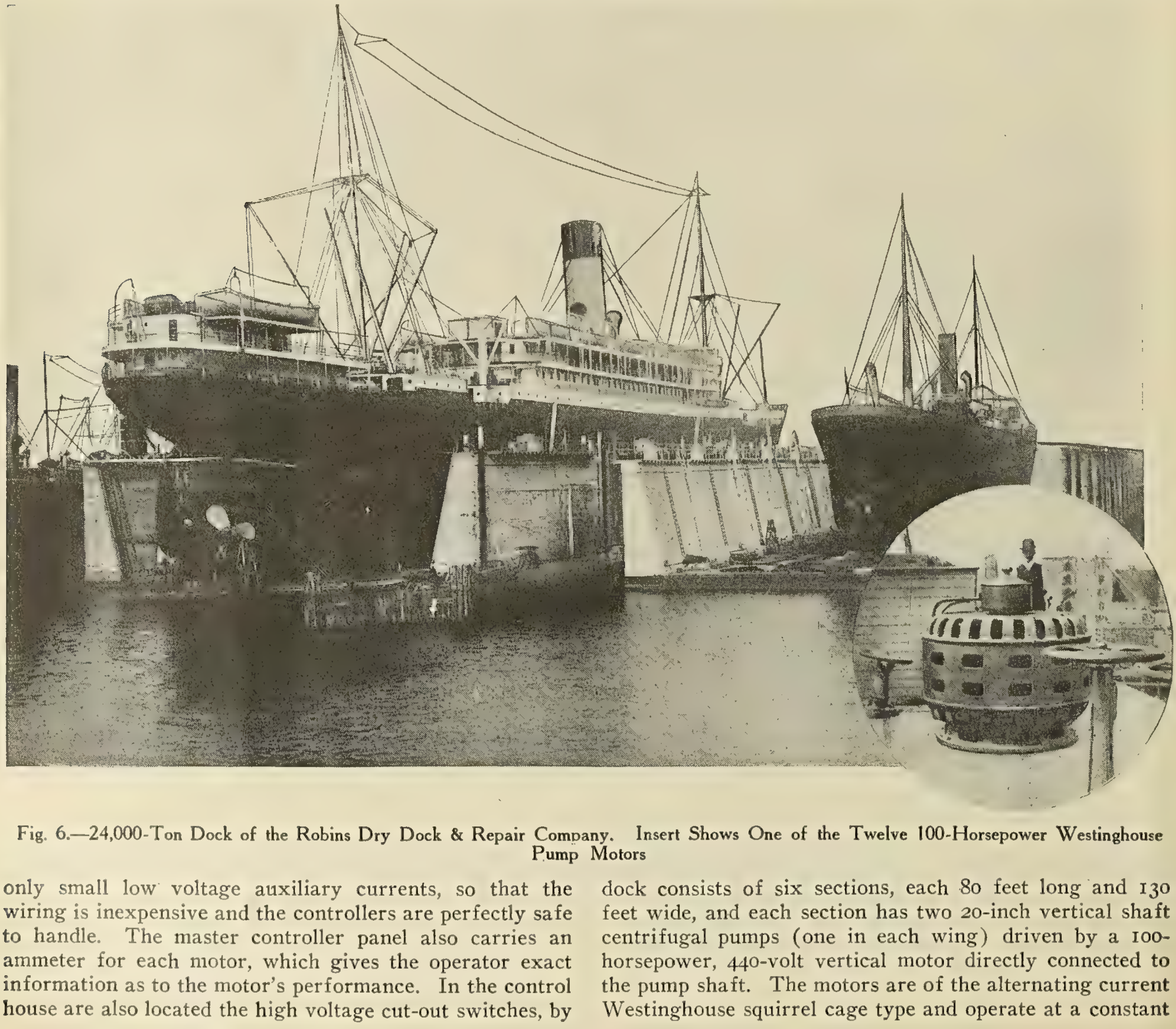


Fig. 6.—24,000-Ton Dock of the Robins Dry Dock & Repair Company. Insert Shows One of the Twelve 100-Horsepower Westinghouse Pump Motors

speed of 290 revolutions per minute. They are controlled from a switch house on land, where they are first connected to a source of low voltage for starting and then directly to the 440-volt line for running.

For large docks this use of a separate motor for each pump is to be recommended, from an electrical standpoint, because it eliminates the complication of line shafts and gears and provides a more flexible arrangement. But it is probable that were this dock built today, the motors would be of the variable speed type; they would be controlled by master controllers and automatic switches, and it is quite likely that they would be operated directly from the high-voltage lines of the central station supplying the current.

Electrically Operated Valves a Possibility

As far as the writer is aware, no dock is using electricity to operate the valves as well as the pumps. That this is possible is shown by the fact that several water supply companies operate distant valves by means of motors and open and close them by merely pressing buttons. If a similar arrangement were used on a dry dock, the control of all of the machinery could be centered at one point.

The Status of Ship Data

BY C. H. PEABODY, DR. ENG.

In the design of a ship, existing data that have been used in previous constructions of a similar character are depended on largely for determining the qualities which will be embodied in the ship. The information available on such questions as the metacentric height of vessels, as well as skin friction and residual resistance is very meager. In fact, the determination of the latter, as well as the power necessary for a given vessel, is left to the theory of mechanical similitude with a resulting accuracy open to question. These matters are discussed in the following article and certain suggestions made for improving the present methods used in displacement, stability, power and strength calculations.

IT may be interesting to review the present status of the data available for computation of the properties of steamships. There are four classes of problems that arise concerning displacement, stability, power and strength.

The displacement may be computed from the lines with accuracy and certainty; the complementary problem of determining the weight of the ship is more difficult and uncertain, especially as there is little published information of ships' weights, but all shipyards have their weight computations and comparisons with displacement and the practical naval architect has no serious difficulty unless he is confronted with some very unusual new problem. It is difficult to assign the precision practicable in this problem, but two or three percent should cover the margin between expectation and realization.

The Ship's Draft

The most important matter in connection with this problem is the draft of the ship, which determines the harbor that the ship can conveniently enter. Now the displacement is roughly proportional to the draft, so that a ship drawing 20 feet may have an overdraft of about half a foot on account of the two or three percent displacement just suggested as the margin of error. Such an overdraft is more an annoyance than a defect unless the assigned draft for the design is the limit available, or unless load line regulations are drastic. To be sure, an overloaded ship is harder to propel, but the loss of speed on account of two or three percent overload is probably only half of the percentage of such overload and is difficult to determine under the best trial conditions. The problems of weight and displacement may therefore be satisfactorily dealt with.

Difficulty of Locating Center of Gravity

The location of the metacenter can also be determined with accuracy and certainty from the lines, but the location of the center of gravity of the ship is the uncertain feature of this problem. Improvised inclining experiments are likely to be troublesome and uncertain, but if a shipyard will take the trouble to make proper provision, there is no reason why it should cause either undue trouble or delay to incline a ship when it is undocked.

Metacentric Height

There is so little information published or unpublished concerned the real metacentric heights of ships that no margin can be assigned to this quantity. The real problem of stability of a steamship is the estimation of the probable time of rolling, so that the designer may be reasonably certain that the ship will be easy in a seaway. Now the square root of the metacentric height enters into the computation of the time of rolling. A desirable time of rolling of a seagoing ship is something like ten seconds, and it is unlikely that the navigator will be able to distinguish the effect of a second more or less in the time of rolling of a given ship even when the effective time of the waves approaches that of the rolling. Consequently, we may say that there is an allowable margin of 20 percent on the metacentric height of a ship in seagoing condition. Truly, the naval architect should see to it that there is a reasonable provision of metacentric height in all normal conditions of loading and unloading, so that there will be no danger of the ship capsizing at her berth, but that is another matter.

Power for a Given Speed

The most exigent problem of the naval architect is the determination of the power required for a given speed, as any serious failure in this regard is immediately evident. There is an enormous amount of data concerning this problem, including, of course, the allied problem of the propeller. The data may be separated into two classes, that from experiments in towing tanks and that from power and speed trials of ships.

There are in all about eighteen model towing tanks, and of them half a dozen have published results of tests on ships' models or series of such tests, two of them have published extensive series of tests on model propellers, at least three have published information concerning the interrelations of the ship and its propeller. There have also been published results of the trials of sizable self-propelled models. This source of information has not been completely digested and prepared for the use of the designer, but there are two monumental works that enable the naval architect to use the general results with reasonable convenience, by Admiral D. W. Taylor and by G. S. Baker.

From Admiral Taylor's books the resistance of a model of a ship may be determined with certainty and precision provided that the ship comes within his limits and provided its speed does not come near a critical condition. The last proviso may ordinarily be met, as naval architects usually avoid critical speeds; the first, unfortunately, may be an obstacle, as the models tested were of naval types, which do not run to large block coefficients. And, again, Admiral Taylor's work on model propellers gives certain and nearly complete information for all kinds and conditions of model propellers. The only real deficiencies are concerning propellers for towboats and propellers liable to run into cavitation: the last statement is almost an hibernicism, as model propellers do not cavitate.

Continuing with cavitation, to dispose of it so far as we are now concerned, it may be said that all the information we have is Barnaby's 11¼ pounds at which the *Daring* cavitated and Speakman's recommendation that the propeller tips be limited to a speed of about 14,000 feet per minute. Everybody who approaches cavitation shys away from it and says no more about it.

The matter of the interrelation of the ship and its propeller is far from a satisfactory condition, though much work has been done by the Froudes, by W. J. Luke and by Naval Constructor McEntee. Attention may be called to the fact that the wake factor and the thrust deduction, as published, apply to models, and all we know about the corresponding quantities for ships is that they are smaller, but we don't know how much smaller.

Value of Power and Speed Trial Reports

There are numerous reports of power and speed trials of ships of all sorts and by various people, and a few reports of economy trials. This mass of material should be collected and criticised drastically by a master in order that the good may be selected and arranged for convenient use. Also there should be propaganda in favor of ship's trials under proper conditions. The writer has had enough experience to understand the difficulties of arranging trials of ships and the conditions requisite for valuable results. From this experience, and from the experience of those versed in the results of trials of naval vessels, the writer has become skeptical of the scientific value of the great mass of ships' trials and of all systems of powering ships and computing propellers that are based on the undigested mass of this information.

In the application of the results of tests of models either in comparison with trials of ships or in the design of ships, Froude's method is always used. First the surface friction is computed and subtracted and the residual resistance is isolated. So far so good; Froude's original determination of surface friction of models was unquestionably correct and has been verified over and over again by many observers. In fact, the first job for a new model tank is to measure surface friction, and if results are satisfactory the observer knows that his apparatus is working right.

Residual Resistance Computed by Means of Theory of Mechanical Similitude

The next step is to treat the residual resistance of the model by the theory of mechanical similitude in order to compute the residual resistance of the ship; thereto is added the surface friction resistance by the use of Froude's factors and exponents, which were determined half a century ago and never repeated. There is a common, though erroneous, idea that Tideman made such determinations, but in his work printed in Dutch he specifically says he did not make any tests on surface friction.

The most crying need of the profession at this moment is a competent determination of the surface friction of ships so that Froude's method may be checked. Such an investigation will be neither easy nor cheap.

Now for the application of the theory of mechanical similitude to the residual resistance; its application must be based on the fact that it conforms with the theory of the trochoidal wave, and the assumption that waves accompanying ships are trochoidal. Though it is quite certain that ships' waves are not trochoidal, the assumption is sufficiently justified by the general theory of waves and by observation on trains of waves accompanying ships and their models. Moreover, the residual resistance is usually less than a quarter of the total resistance and approaches a half only for extreme cases, where new designs are largely experimental.

So far as can be judged from tests of various sizes of propeller models, the theory of mechanical similitude applies fairly well, but the gap from a 16-inch model to a 10- or 20-foot propeller is wide. The need for experimental work to close the gap is evident, also the difficulty and extravagance of the work.

Mechanical Efficiency of Reciprocating Engines

There remains the question of mechanical efficiency of the reciprocating engine, usually estimated more or less optimistically. Truly, tests have been made by the aid of torsion meters which encourage optimism.

The experience of experts who have compared tests of models and their propellers with trials of the ships is that there is a margin of discrepancy of about 2 percent in power. That is to say, the indicated power is liable to be 10 percent less than the power estimated from the model. This makes us think that Froude's friction data are too high, which should be expected. This discrepancy, when it exists, is rather comforting, as it eases up on the designer. If we wish to be precise, we may just estimate a 2 percent discrepancy and let it go at that. Should the real discrepancy prove to be 8 percent on the one hand or 12 percent on the other, we will be only 2 percent out.

Accuracy of the Admiralty Coefficient

There remain the independent estimate of power and the Admiralty coefficient. The independent estimator uses Froude's method, going from ship to ship instead of from model to ship. Some designers use it with great satisfaction for certain classes of ships. As for the Admiralty coefficient, the oldest and by many thought to be the most reliable method, it is fundamentally an application of the theory of similitude. Some designers prefer the direct application of the theory from ship to ship, a method that has some advantages, but the Admiralty coefficient properly derived from similar ships at corresponding speeds is an old reliable method. If we had information enough under all conditions, we should need nothing better. Its worst feature is its conservatism, discouraging adventures into new fields.

Finally there is no reason why the designer should not be confident when called upon to power any ship that is not a freak. The law of power and speed favors him, namely, the law that the power varies as the cube of the speed, for conversely the speed varies as the cube root of the power.

An error of 9 percent on the power may cause a variation of 3 percent on the speed, which is where any discrepancy shows up.

Strength of Ships

All problems of strength of ships are relative, because the action of the sea cannot be predicted. There is, of course, the customary calculation for longitudinal strength, treating the ship as a beam supported on a wave of the same length and loaded with the weight of the ship's structure, the machinery and the cargo. Then results a stress computed for the material of the strength deck; if the stress so computed is unusual, and especially if it is unusually small, the designer takes notice and in the latter case goes about strengthening the deck. Such computations as have been suggested for transverse strength are difficult and uncertain. The chief reliance of the designer must be precedent and progress, which must be made slowly step by step. There have been a few instances of ships breaking in a seaway—for example, the destroyer *Viper*—but the chance of failure of conservatively designed merchantmen is very remote. Since registration societies specify the scantlings for all classes of ships, the designer has little scope for originality, except as he proposes some equivalent construction for that specified.

Fruit Steamers Hibueras and Nicarao

Combined Fruit and Passenger Vessels Built by the Standard Shipbuilding Corporation for Service in the Honduran Fruit Trade

BY CHARLES FELDMAN

THE Standard Shipbuilding Corporation, Shooters Island, N. Y., has completed its first private contract since the war construction period. The vessel is the steamship *Hibueras,* one of the two special type combination fruit and passenger steamers recently constructed for, and delivered to, the Cuyamel Fruit Company, New Orleans, La. The *Hibueras* and her sister ship, the *Nicarao,* which were built under the supervision of William Gardner & Company, New York, were transferred without change of ownership to Honduran registry while under construction, their hailing port being Puerto Cortez.

These ships are reported to be the first combination fruit and passenger steamers constructed in the United States for foreign registry.

The vessels were built and classed to the rules of Lloyd's Register of Shipping, *100 A-1, shelter deck, and in accordance with the rules and regulations of the United States Steamboat Inspection Service.

Principal Dimensions

The principal dimensions of these steamers are as follows:

Length between perpendiculars	235 feet 0 inches
Length overall	248 feet 0 inches
Beam, molded	34 feet 0 inches
Depth to upper deck	16 feet 0 inches
Depth to shelter deck	23 feet 6 inches
Sea speed at load draft of 15 feet 8 inches	11 knots

General Arrangement

From the general arrangement plans (Figs. 3 and 4) it

Fig. 1.—Passenger and Fruit Steamer *Hibueras,* Designed by William Gardner, of New York

will be seen that the steamer is of the shelter deck type, with two permanent continuous decks for the full length of the ship and a portable sparred wood orlop deck, with steel beams, forward and aft of the machinery space. On the shelter and boat decks steel and wood superstructures are built for the housing of the crew and passengers.

A cellular double bottom extending the full length of the ship between the peak bulkheads is used for stowing fuel oil, excepting the part under the engine, in which feed water is carried.

Scantlings

Forgings—

Stem, 7 inches by 2⅛ inches.
Rudder post, 6¼ inches by 5 inches.
Propeller post, 7 inches by 5 inches.

Frames—

Spacing, 22½ inches.
Bulb angles, 6 inches by 3 inches by .35 inch.
Frames in peaks, 5 inches by 3 inches by .38 inch.

Beams—

Shelter deck, every frame, angles, 5 inches by 3 inches by .312 inch.

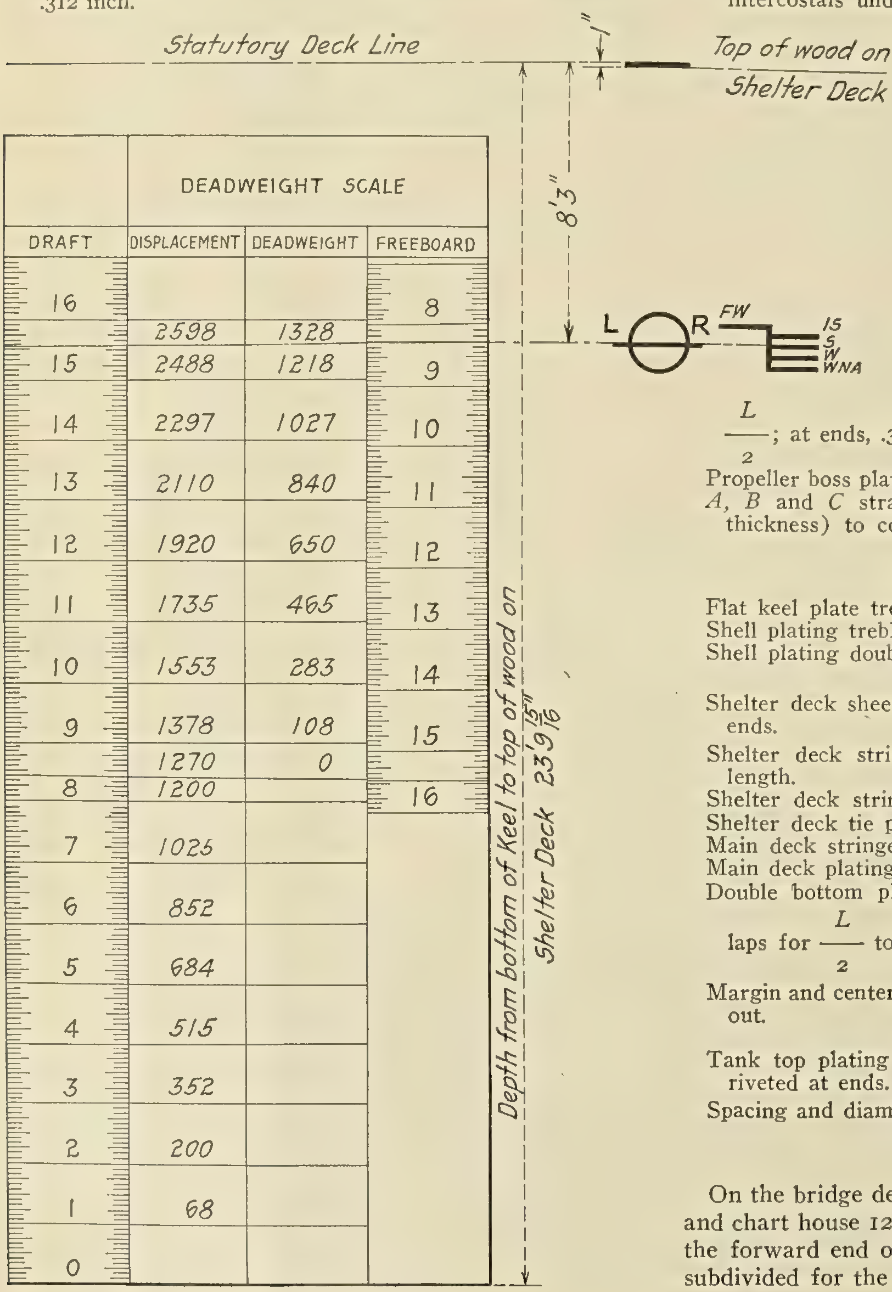


Fig. 2.—Capacity Diagram

Second deck, every frame, angles, 5 inches by 3 inches by .34 inch.
Pillars in engine room to be arranged where practicable.

Double Bottom

Plating—

Center strake, 33 inches by .38 inch for $\frac{L}{2}$; ends, .32 inch.
Center strake, .46 inch in boiler space.
Other strakes, .30 inch $\frac{L}{2}$; ends, .28 inch.
Other strakes, .46 inch in boiler space.
Other strakes, .34 inch in engine space.

Floors and Brackets—

.30 inch for $\frac{L}{2}$; ends, .30 inch.
Floors .40 inch in boiler space.
Floors in peaks .32 inch.
Floors to be fitted at every frame in engine space and under boiler bearers and from the 3/5 length forward to collision bulkhead. No holes to be made in floors and intercostals under pillars.

Outside Plating

From keel to upper turn of bilge, .46 inch for $\frac{L}{2}$; at ends, .38 inch.
From bilge to strake below sheerstrake, .46 inch for $\frac{L}{2}$; ends, .38 inch.
Strake below sheerstrake, 41 inches by .46 inch for $\frac{L}{2}$; at ends, .38 inch.
Sheerstrake, 41 inches by .48 inch for $\frac{L}{2}$; at ends, .38 inch.
Propeller boss plate, .48 inch.
A, *B* and *C* strakes to be carried forward (of midship thickness) to collision bulkhead.

Riveting Schedule

Flat keel plate treble rivet laps throughout.
Shell plating treble rivet butt laps for ½ *L*.
Shell plating double rivet butt laps at ends.
Shelter deck sheerstrake treble rivet for $\frac{L}{2}$ to double at ends.
Shelter deck stringer plate treble rivet butt laps for ½ length.
Shelter deck stringer plate double riveted at ends.
Shelter deck tie plates double riveted butt laps throughout.
Main deck stringer plates double riveted butt laps.
Main deck plating, single riveted butt laps throughout.
Double bottom plating, center keelson treble riveted butt laps for $\frac{L}{2}$ to double at ends.
Margin and center strake of tank top double riveted throughout.
Tank top plating double riveted butt laps for $\frac{L}{2}$, single riveted at ends.
Spacing and diameters of rivets as per Lloyd's Rules.

Accommodations

On the bridge deck there is located a combination wheel and chart house 12 feet long and 9 feet 6 inches wide. At the forward end of the boat deck there is a wood house subdivided for the captain's stateroom, office, bathroom, a stateroom for the first officer and one for the second and

FRUIT STEAMERS HIBUERAS AND NICARAO

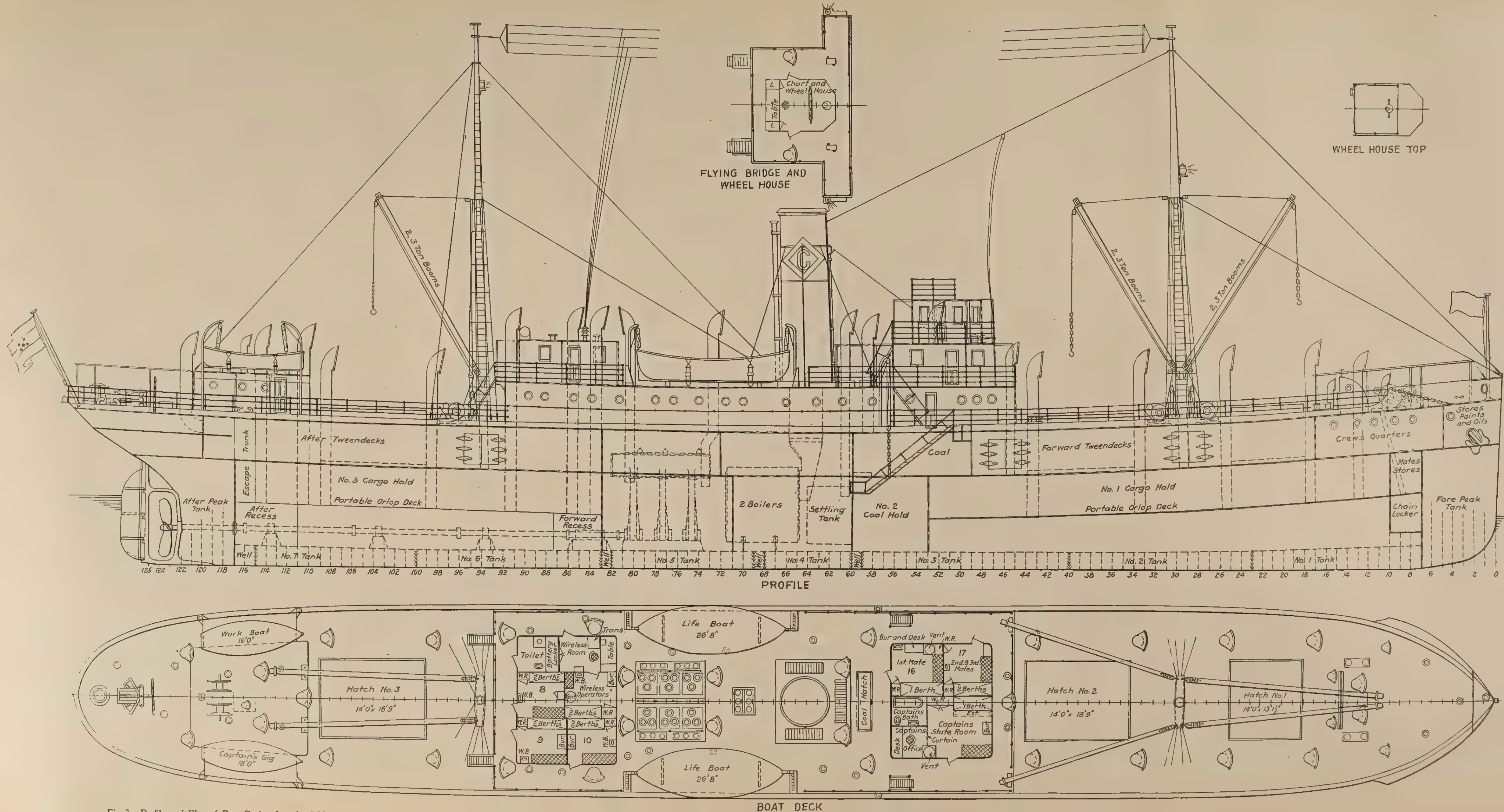


Fig. 3.—Profile and Plan of Boat Deck: Length of Vessel Overall, 248 Feet; Length Between Perpendiculars, 235 Feet; Beam, Molded, 34 Feet; Depth to Upper Deck, 16 Feet; Depth to Shelter Deck, 23 Feet 6 Inches; Load Draft, 15 Feet 8 Inches; Indicated Horsepower, 1,150; Designed Speed at Load Draft, 11 Knots

FRUIT STEAMERS HIBUERAS AND NICARAO

HOLD CAPACITIES
(Including Hatches)

Location	Gross Cubic Feet	Net Cubic Feet
Hold No. 1	32,776	27,120
Hold No. 3	21,175	18,150
Tweendecks No. 1	14,708	10,827
Tweendecks No. 3	15,971	12,827
Total	84,630	68,924

NOTE.—Gross capacity calculated to top of beam, outer edge of frames and top of tank ceiling. Net capacity calculated to bottom of beams, inner edge of cargo battens and top of tank ceiling.

WATER BALLAST CAPACITIES

Tank	Location	Capacity in Tons
No. 1 tank	Frame 7 to 23	22.6
No. 2 tank	Frame 23 to 40	52.8
No. 3 tank	Frame 40 to 59	71.0
No. 4 tank	Frame 60 to 68	31.0
No. 5 tank	Frame 69 to 82	49.4
No. 6 tank	Frame 83 to 100	52.3
No. 7 tank	Frame 100 to 115	26.0
Fore peak	Frame 0 to 7	33.9
After peak	Frame 117 to 125	35.5
Total		374.5

COAL BUNKER CAPACITIES

Location	Tons	Cubic Feet
Hold, frame 53 to 60	122.3	5,500
Tweendecks, frame 49 to 60	111.2	5,000
Rake bunker, frame 72 to 60	44.5	2,000
Total	278.0	12,500

TONNAGE PARTICULARS

Gross	1,445.44
Net	819.08

STATEROOMS

Number	Port Side	Accommodations for
1	Passengers	3
2	Passengers	3
3	Passengers	3
4	Passengers	3
5	Passengers	3
6	Passengers	3
15	Steward	1
16	First mate	1
17	Second and third mates	2

Number	Starboard Side	Accommodations for
7	Passengers	3
8	Passengers	3
9	Passengers	3
10	Passengers	3
11	Chief engineer	1
12	First assistant engineer	1
13	Second and third assistant engineers	2
14	Cooks	2

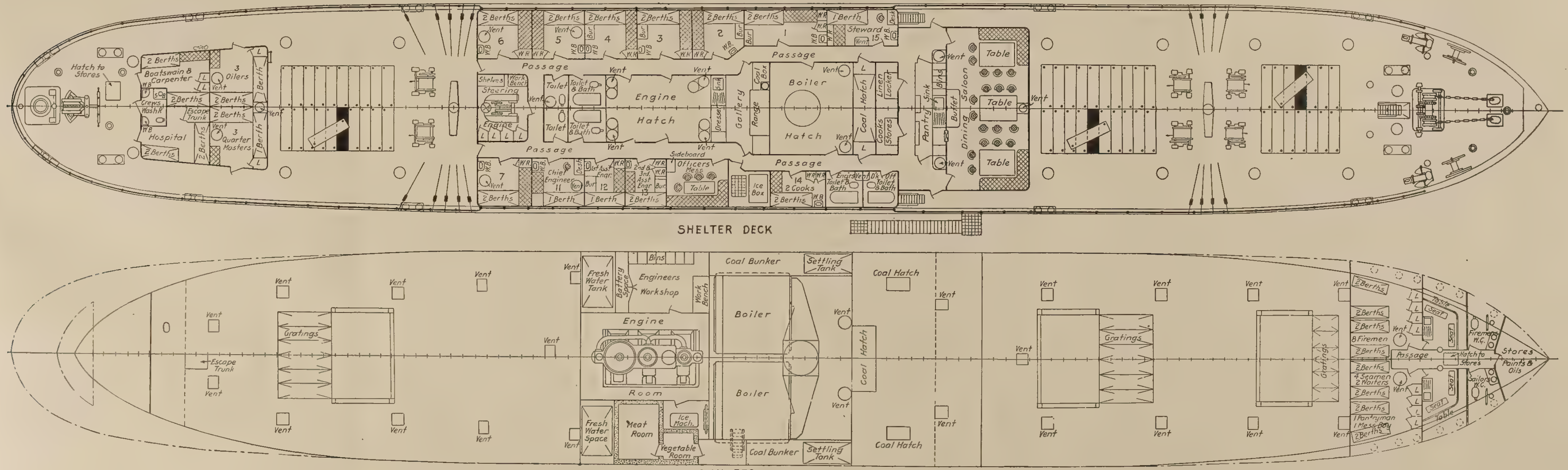
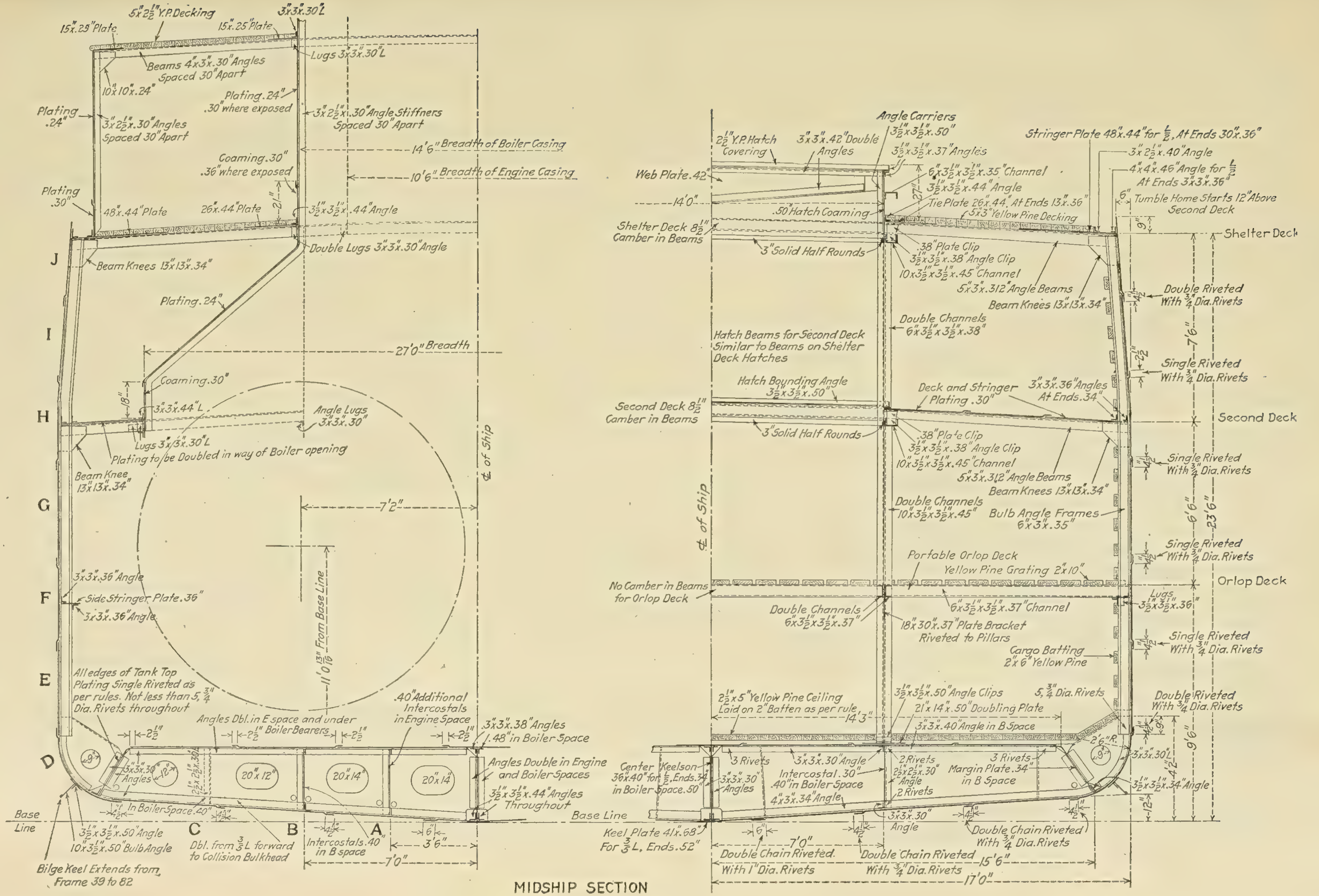


Fig. 4.—General Arrangement Plans of Shelter and Main Decks



MIDSHIP SECTION

Fig. 5

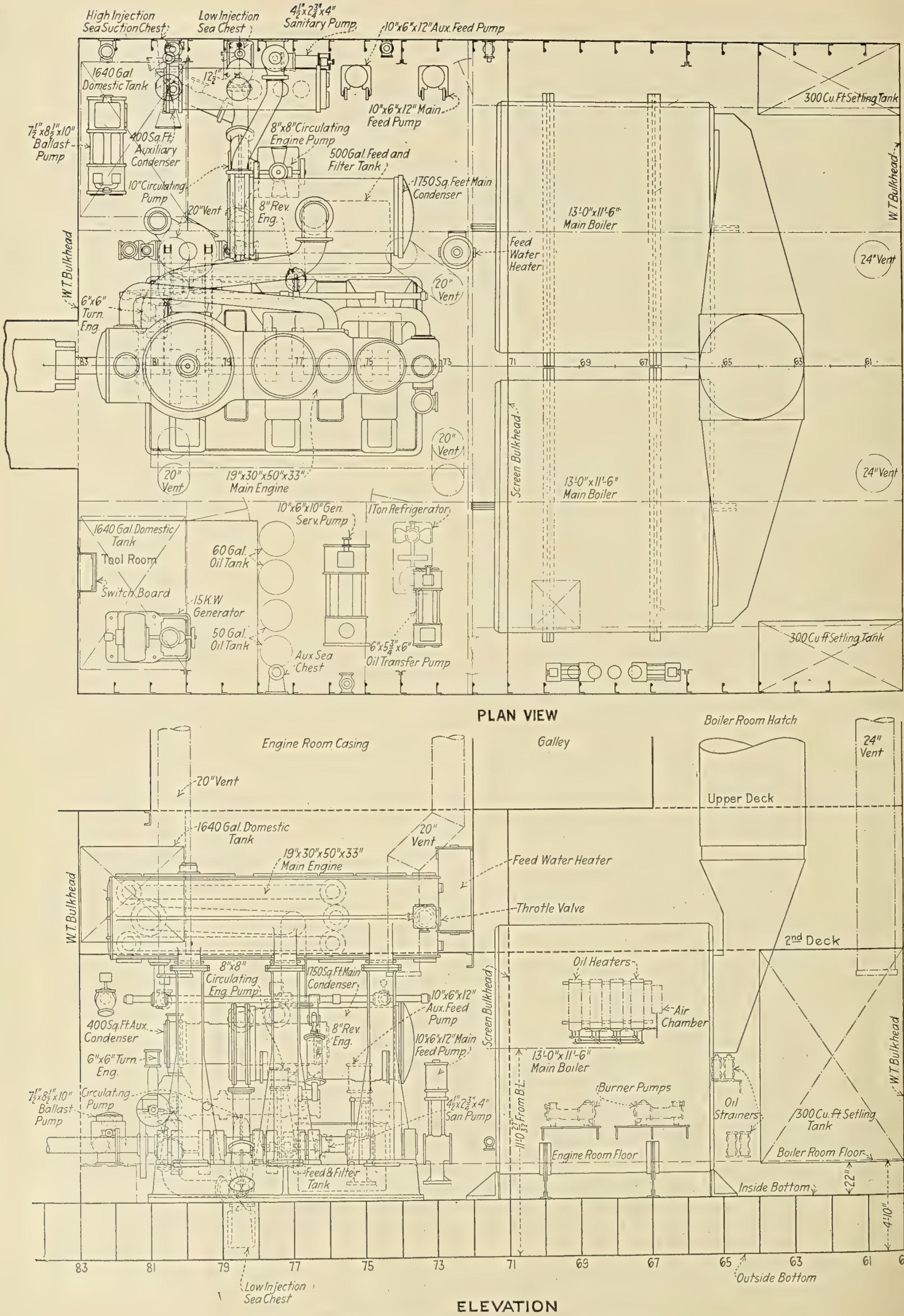


Fig. 6.—Plan and Longitudinal Section of Machinery Space

third officers. At the after end of the boat deck there is located a wood house arranged for three passenger staterooms, toilet room, wireless operator's stateroom and wireless work room. A steel midship house on the shelter deck is subdivided for seven passenger staterooms, passengers' dining room, galley, pantry, storeroom, also staterooms for the steward, cooks, four engineers, officers' messroom, and bath and toilets for passengers and officers. The petty officers' quarters, together with the hospital, wash and toilet rooms, are located in a steel house at the after end of the shelter deck. The balance of the crew is quartered at the fore end of the vessel between the main and shelter decks.

Propelling Machinery

The main engine is of the vertical, inverted cylinder, surface condensing, three cylinder, triple expansion type, right hand when working in the ahead motion.

The particulars of the engine are as follows:

Diameter of high pressure cylinder, inches	19
Diameter of intermediate pressure cylinder, inches	30
Diameter of low pressure cylinder, inches	50
Stroke, inches	33
Working pressure, pounds per square inch	185
Indicated horsepower	1,150
Revolutions per minute	95

Boilers

Steam is generated by two cylindrical, single end boilers of the Scotch type, 13 feet inside diameter by 11 feet 6 inches long, with a working pressure of 185 pounds per square inch. The effective heating surface is 1,820 square feet each, and there are three furnaces of the Morison suspension type in each boiler.

Auxiliaries

The machinery installation also includes the following:

One condenser of the cylindrical type, fitted in the engine room, with a total cooling surface of 1,750 square feet.

One centrifugal circulating pump of double suction type, with 10-inch diameter pipe connections.

Two main and auxiliary feed pumps of the vertical double acting simplex type, composition fitted, having one 10-inch steam cylinder, one 6-inch water cylinder and a 12-inch stroke.

One horizontal donkey and fire pump, duplex type, composition fitted, 10-inch by 6-inch by 10-inch.

One horizontal, duplex type, ballast pump, 7½ inches by 8½ inches by 10 inches.

One horizontal sanitary pump, 4½ inches by 3¾ inches by 4 inches.

Two horizontal oil fuel pumps, duplex type, 4½ inches by 2¾ inches by 4 inches, installed for oil service. These pumps are connected to manifold boxes, meter, heaters, burners, etc.

One horizontal oil transfer pump, 6 inches by 5¾ inches by 0 inches, has been installed for the transfer of fuel oil from the double bottom to settling tanks.

One metropolitan double tube type injector, with 2½-inch connections.

Hatches and Cargo Handling

There are three cargo hatches which are half-encased with vertical gratings, thus permiting free air circulation. Through the open halves of the hatches a conveyor can be lowered for unloading the cargo, in this way eliminating the possibility of bruising and losing the fruit cargo. The hatches, which are on the shelter deck, have a tent-like covering to permit the hatch covers being left off in good weather, this arrangement greatly increasing the fresh air supply.

The three hatchways are served by six 3-ton capacity Oregon pine cargo booms, four being fitted on the foremast and two on the mainmast. The booms are served by six Clark-Chapman horizontal steam winches with double cylinders, 6 inches by 10 inches, two speeds, link reverse gear, of three-ton lifting capacity.

Three cargo ports 6 feet long by 5 feet 6 inches high are also provided on each side of the vessel, efficient watertight doors being provided to close them when under way.

Ventilators

The holds of the vessels are fitted for carrying fruit and are therefore well ventilated by natural draft, twenty-four 24-inch diameter ventilators and three 21-inch diameter sheet steel ventilators having been installed. These ventilators have strong steel plate coamings ½ inch thick and 30 inches high above the shelter deck. Handles for turning the ventilators are fitted, and the cowls and vent pipes exposed to weather are galvanized.

Other ventilators installed on the steamers are as follows:

One 9-inch diameter ventilator to shaft alley.

One 9-inch diameter ventilator to fore peak storeroom.

Two 9-inch diameter ventilators to after peak storeroom.

(*Continued on page 821.*)

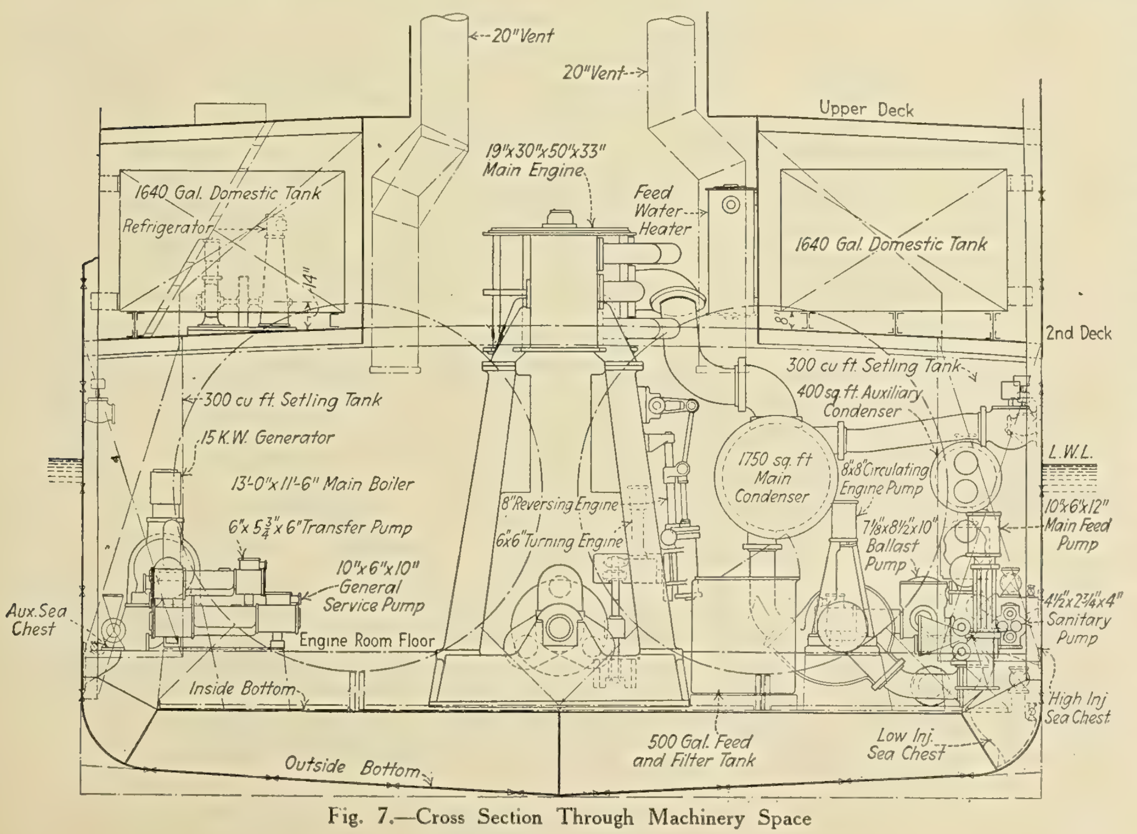


Fig. 7.—Cross Section Through Machinery Space

Lake Bulk Freighter Horace S. Wilkinson

Single Screw, Shelter Deck Steamer of 12,120 Net Tons Deadweight Carrying Capacity Built by the Toledo Shipbuilding Company

An exceptionally fine example of the shipbuilding art as carried on along the Great Lakes is the bulk freighter *Horace S. Wilkinson,* constructed by the Toledo Shipbuilding Company, Toledo, Ohio, for the Great Lakes Steamship Company.

This vessel has a deadweight carrying capacity of 12,120 net tons and is of the usual single deck type of freighter employed on the Great Lakes, with forecastle and after deck house, the main propelling machinery being located aft.

Principal Dimensions

The principal dimensions of the *Wilkinson* are as follows:

Length overall	600 feet
Length between perpendiculars	588 feet
Length, keel	580 feet
Breadth, molded	60 feet
Depth, molded	32 feet
Depth of double bottom at center	6 feet
Breadth of side tanks	6 feet

Quarters

A steel deck house erected upon the forecastle deck contains the captain's office, stateroom and bathroom and a spare stateroom for the owner or representative, and above this is the pilot house, which is also of steel construction. Quarters for the deck officers and crew are located on the spar deck under the forecastle. The engineers and cooks are quartered in a steel house located on the spar deck aft, which also contains the galley, refrigerator and messrooms.

Hull Construction

The hull of the vessel is built on the transverse system with a flat plate keel and a continuous spar deck. A main deck is fitted at the forward and after ends, the stringer plate being continuous to provide an upper boundary for the side ballast tanks.

Side ballast tanks 6 feet wide are fitted on each side of the vessel, extending from the shell at the bilge to the main deck stringer, and from the collision bulkhead to the forward coal bunker bulkhead. These tanks are subdivided to form three watertight compartments on each side of the vessel. The inboard plating of the side tanks is not stopped at the main deck stringer, but carried up to the spar deck forming a longitudinal strength girder. It is watertight to the main deck stringer.

A double bottom, 6 feet deep at the centerline, is fitted between the collision bulkhead and forward engine room bulkhead, extending from side tank to side tank forward of the forward coal bunker bulkhead and to the side of the ship under the coal bunker and boiler space. A double bottom is also fitted under the engine space extending to the side of the ship. The double bottom is 5 feet deep on the centerline at the forward end and 4 feet deep at the after end. The whole double bottom is divided by a watertight center girder and watertight floors into nine compartments for water ballast, the aftermost compartment terminating forward of the stuffing box bulkhead to allow for the engine room well.

The main cargo space extending from the collision bulkhead to the forward coal bunker bulkhead is divided into four holds by three screen bulkheads. Access to the cargo holds is provided by 35 cargo hatches 9 feet long fore and aft and 12 feet centers.

Telescoping hatch covers of 12½-pound plate are fitted and appliances are provided for operating them by hand or steam. Suitable fittings for securing hatch tarpaulins are also provided.

A chain locker, dunnage room, lamp room and paint locker are located on the main deck forward, and below these are the forward trimming tank and dark hold.

The main deck aft supports the steering engine and closes in the after peak tank located below.

A coal bunker of 500 tons capacity and extending the full width of the ship is located aft between the cargo and boiler space, the bottom of which is hoppered to deliver coal to the bunker doors. Above the spar deck a bunker house the width of the boiler house and 7 feet 6 inches high is built with a bunker hatch 8 feet by 36 feet in the top.

Joiner Work

The captain's office and stateroom and spare stateroom are fitted with paneled walls of quartered oak and ceilings of composition board forming panels. The captain's bathroom is paneled and finished in white enamel.

The pilot house, forecastle containing officers' and crew's quarters, wash rooms and hospital and the after deck house containing engineers' and stewards' quarters, bathrooms, etc., are finished in narrow V-joint oak walls and white painted pine ceilings.

No wood or composition decking of any kind is provided except a wood floor in the pilot house, and all woodwork of the walls is stopped 6 inches above the steel deck.

Propelling Machinery

Steam is generated in three Scotch boilers 13 feet inside diameter by 11 feet long over the heads, each one fitted with two furnaces 48 inches inside diameter and designed for a working pressure of 220 pounds per square inch.

A forced draft installation is fitted to the boilers consisting of a 36-inch fan in combination with a 6-inch by 6-inch blower engine.

The main engine is of the vertical quadruple expansion type with cylinders 21½, 30½, 43 and 61 inches in diameter by 42 inches stroke, arranged with the high pressure cylinder forward followed by the low, second intermediate and first intermediate pressure cylinders respectively. The high and first intermediate cylinders are fitted with piston valves and the second intermediate and low pressure cylinders with double ported slide valves, all valves being operated by the double bar Stephenson link motion.

The propeller is of the sectional type with four blades and is 15 feet 6 inches in diameter.

Auxiliaries

Included in the machinery installation are the following auxiliaries:

One mate's pump, of the horizontal duplex type, 6 by 4 by 6 inches.

One horizontal duplex fire pump, 14 by 7½ by 12 inches.

One horizontal duplex sanitary pump, 5¼ by 3¾ by 5 inches.

One single acting air pump, 40 by 12 inches, operated by a beam attached to the low pressure crosshead.

One 5½- by 10-inch bilge pump and one 4⅞- by 10-inch cooler pump actuated by an arm keyed to an extension of the air pump beam shaft.

One horizontal duplex 8 by 5 by 12-inch boiler feed pump.

One horizontal spiral coil, film feed water heater.

LAKE BULK FREIGHTER HORACE S. WILKINSON

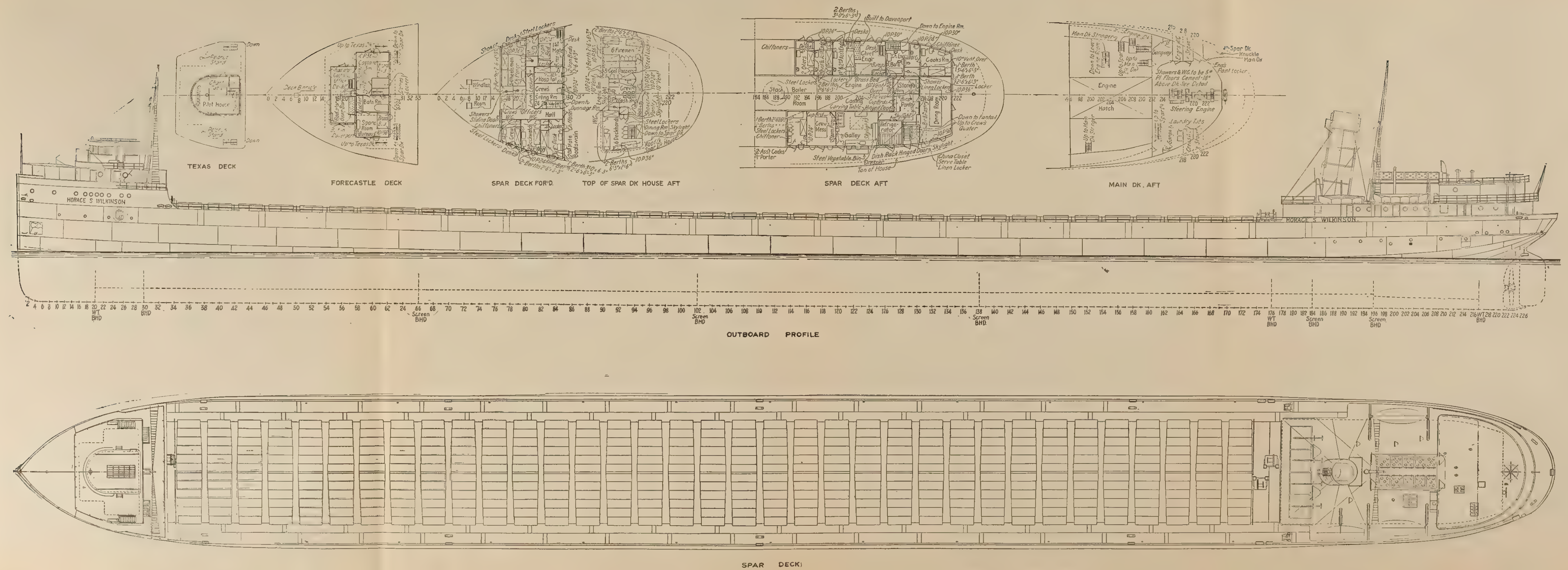


Fig. 1.—General Arrangement Plans: Length Overall, 600 Feet; Length Between Perpendiculars, 586 Feet; Beam, Molded, 60 Feet; Depth, Molded, 32 Feet; Deadweight Carrying Capacity, 12,120 Net Tons

LAKE BULK FREIGHTER HORACE S. WILKINSON

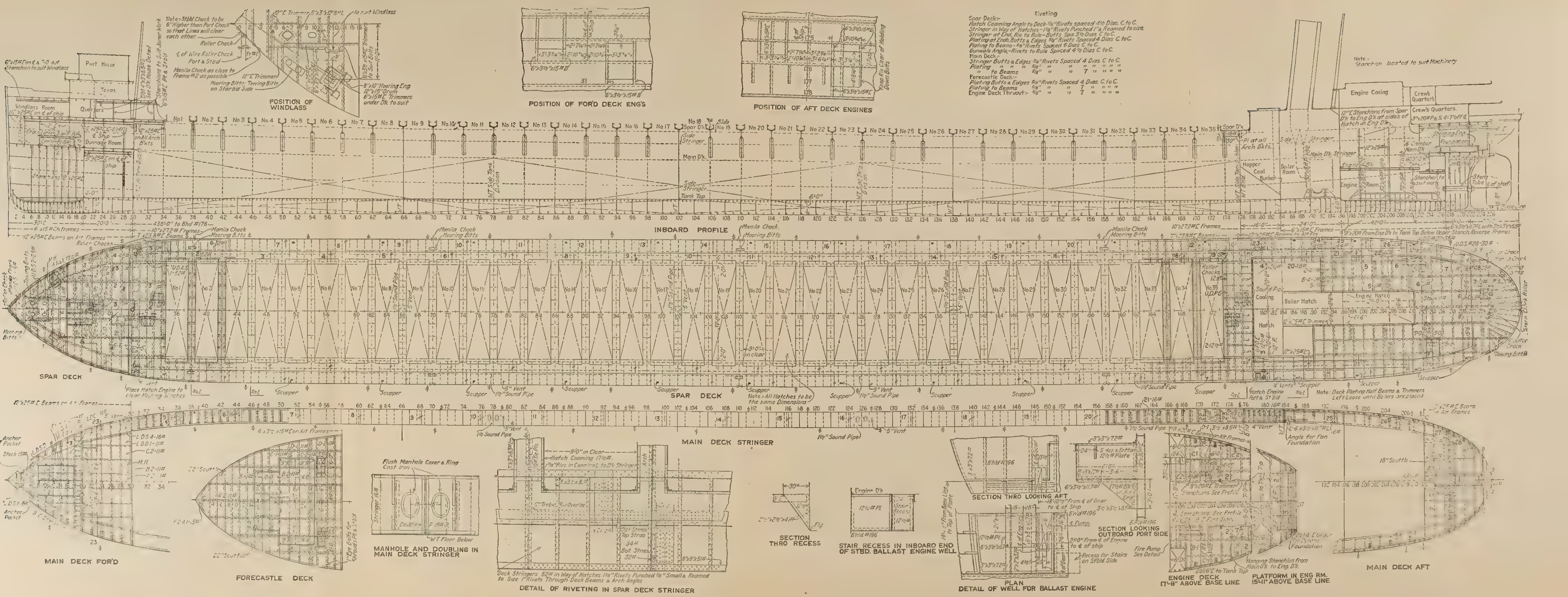
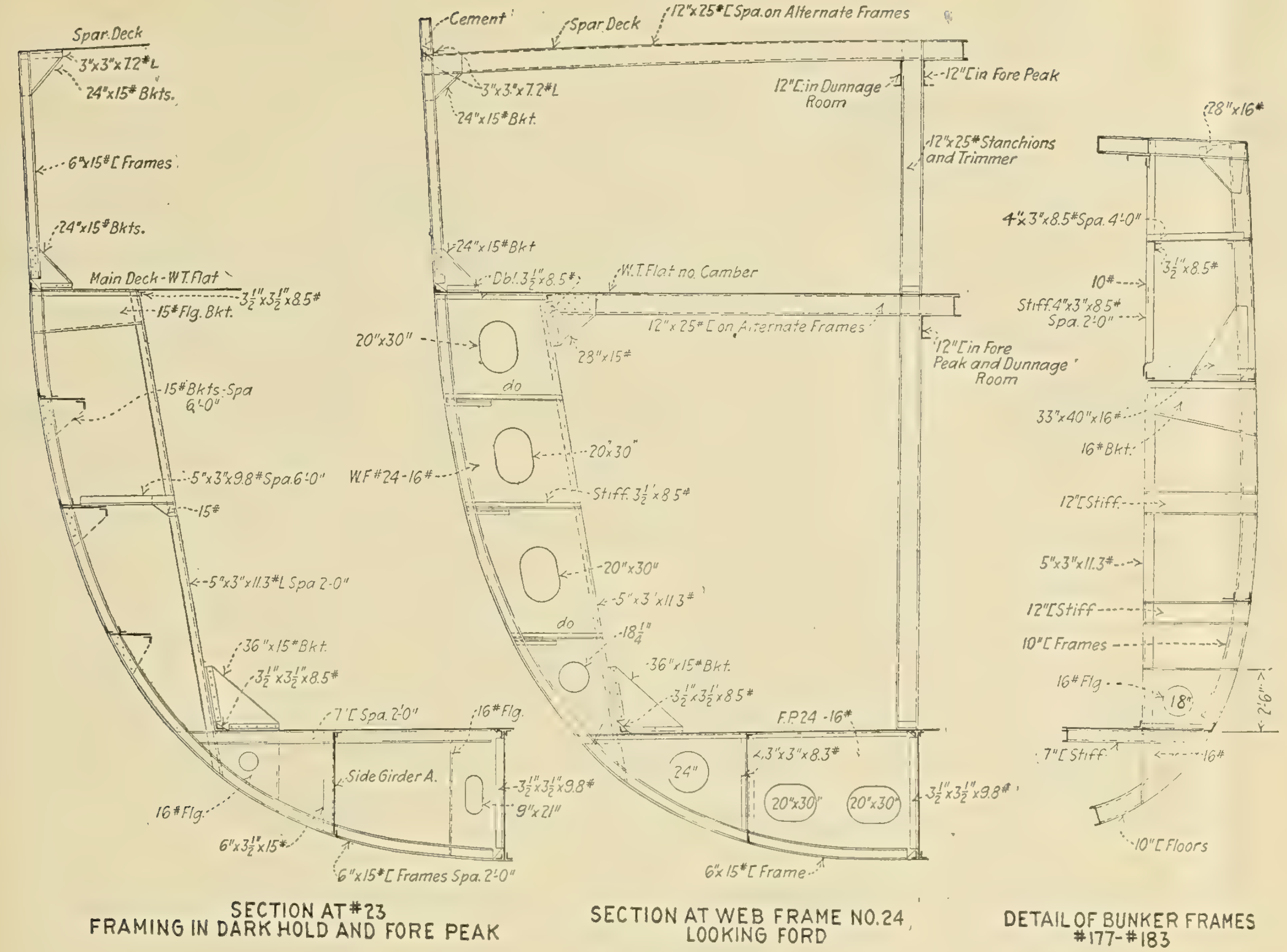


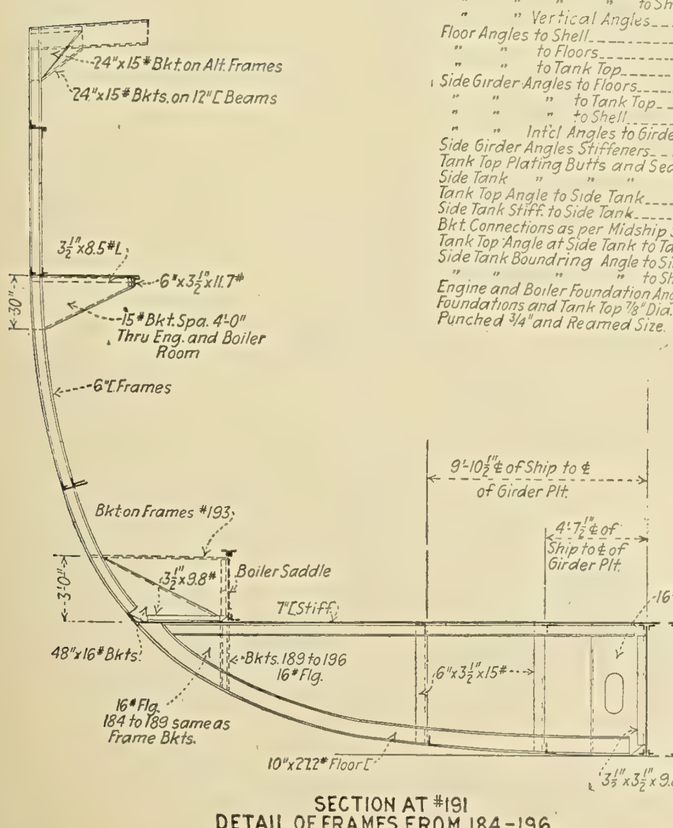
Fig. 2.—Detail Construction Plans



RIVETING NOTES

Center Girder Butts	7/8"	Dia.	Riv	4	Dias. C. to C.
" " Top Angles	7/8"	"	"	5	" "
" " Bottom Angles to Girder	7/8"	"	"	5	" "
" " " " to Shell	1⅛"	"	"	5	" "
" " Vertical Angles	7/8"	"	"	5	" "
Floor Angles to Shell	7/8"	"	"	7	" "
" " to Floors	3/4"	"	"	7	" "
" " to Tank Top	7/8"	"	"	7	" "
Side Girder Angles to Floors	3/4"	"	"	7	" "
" " " to Tank Top	7/8"	"	"	7	" "
" " " to Shell	7/8"	"	"	7	" "
" " Int'cl Angles to Girder. As per Plan					
Side Girder Angles Stiffeners	3/4"	"	"	7	" "
Tank Top Plating Butts and Seams	7/8"	"	"	4	" "
Side Tank " " " "	3/4"	"	"	4	" "
Tank Top Angle to Side Tank	3/4"	"	"	4½	" "
Side Tank Stiff. to Side Tank	3/4"	"	"	7	" "
Bkt. Connections as per Midship Section					
Tank Top Angle at Side Tank to Tank Top	7/8"	"	"	4½	" "
Side Tank Boundring Angle to Side Tank	3/4"	"	"	4½"	" "
" " " " to Shell	7/8"	"	"	5"	" "

Engine and Boiler Foundation Angles Connecting Foundations and Tank Top 7/8" Dia. Rivets Spaced not over 4½" Dias.-Holes Punched 3/4" and Reamed Size.



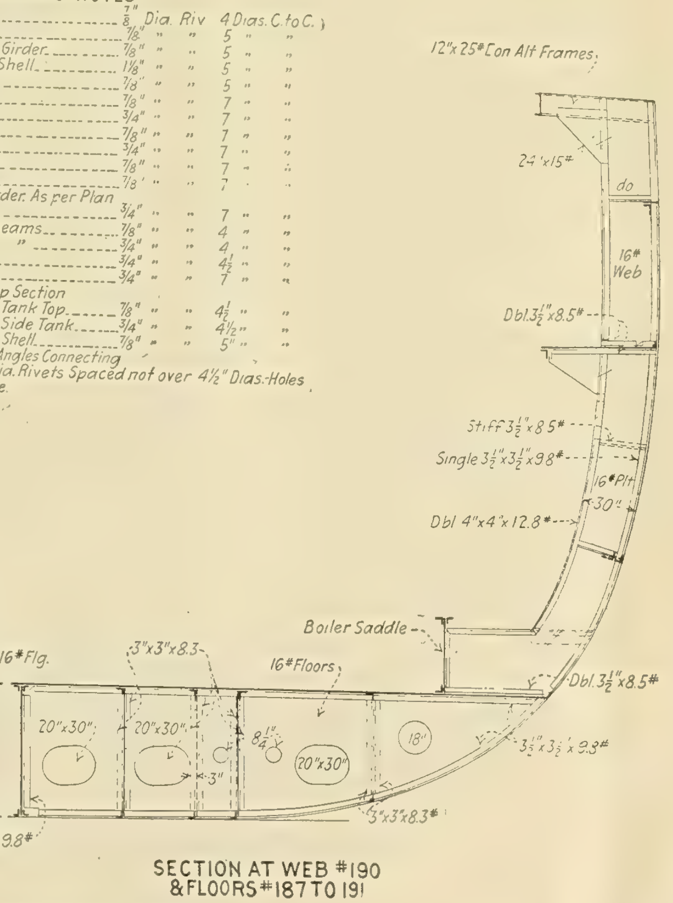


Fig. 3.—Framing and Riveting Details

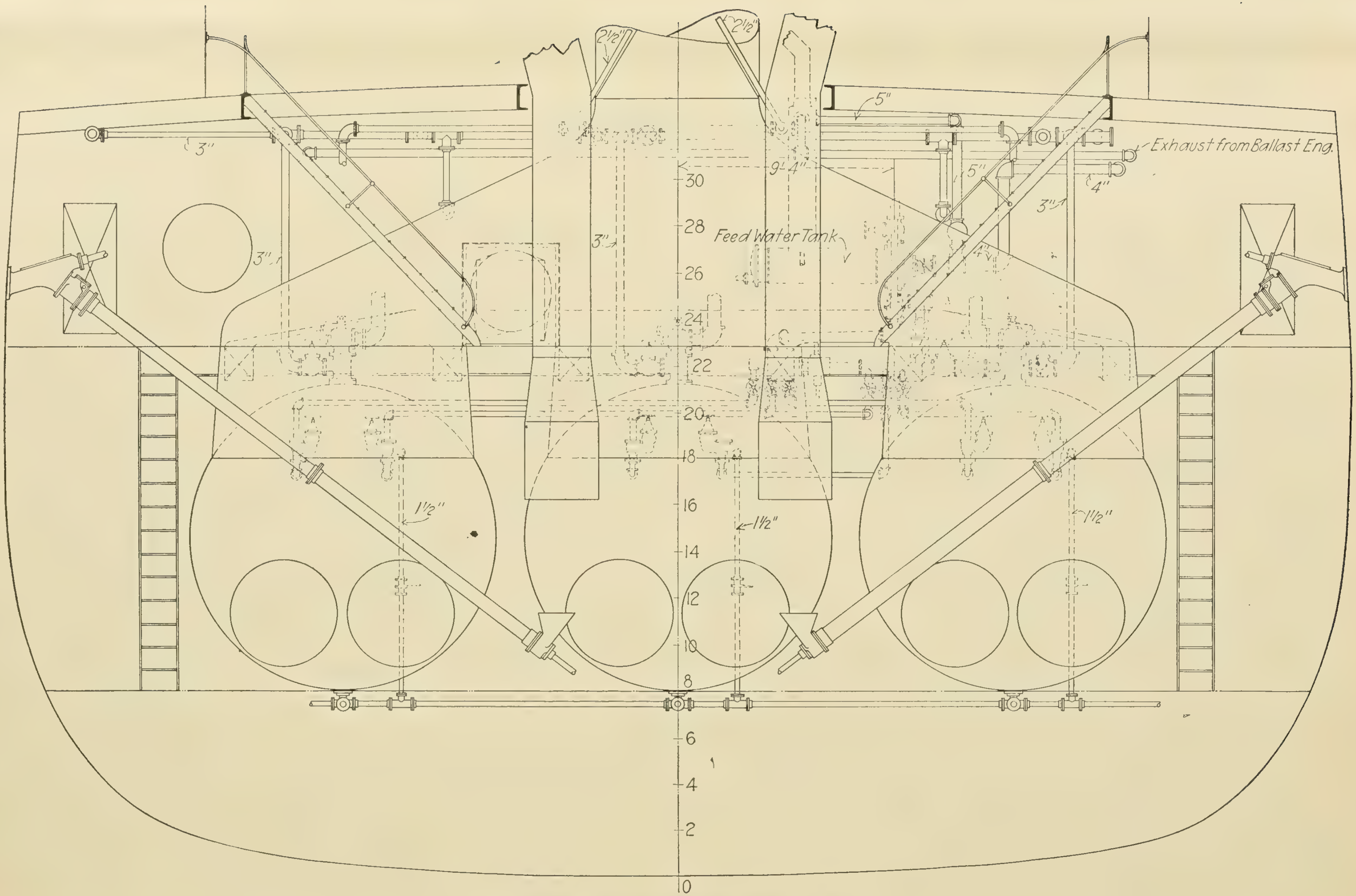
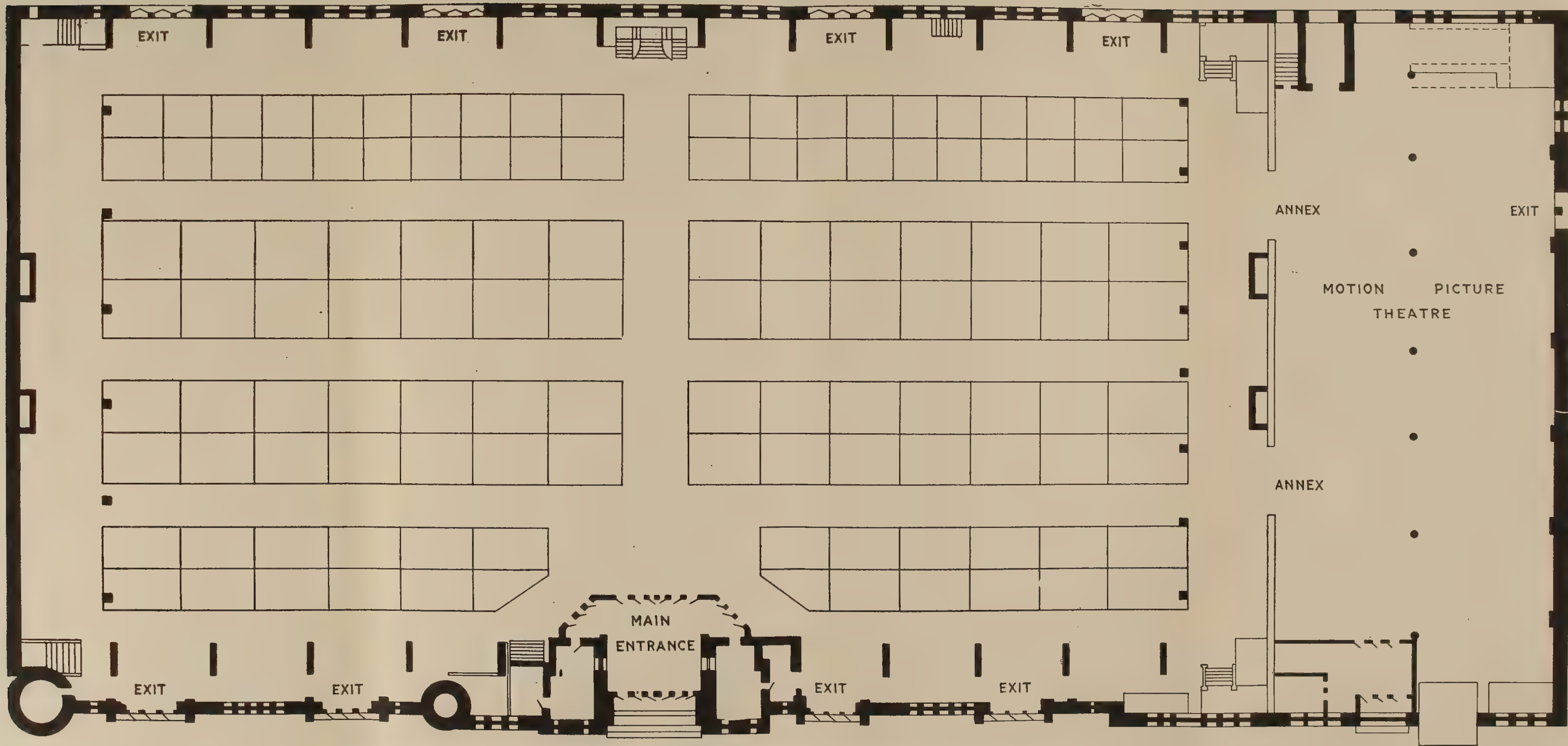


Fig. 4.—Section at Frame 184, Boiler Room, Looking Aft

CHICAGO MARINE EXPOSITION



Floor Plan of the Coliseum in Chicago, Showing Arrangement of Exhibition Booths for the Marine Exposition to Be Held During Marine Week, October 18 to 23

LAKE BULK FREIGHTER HORACE S. WILKINSON

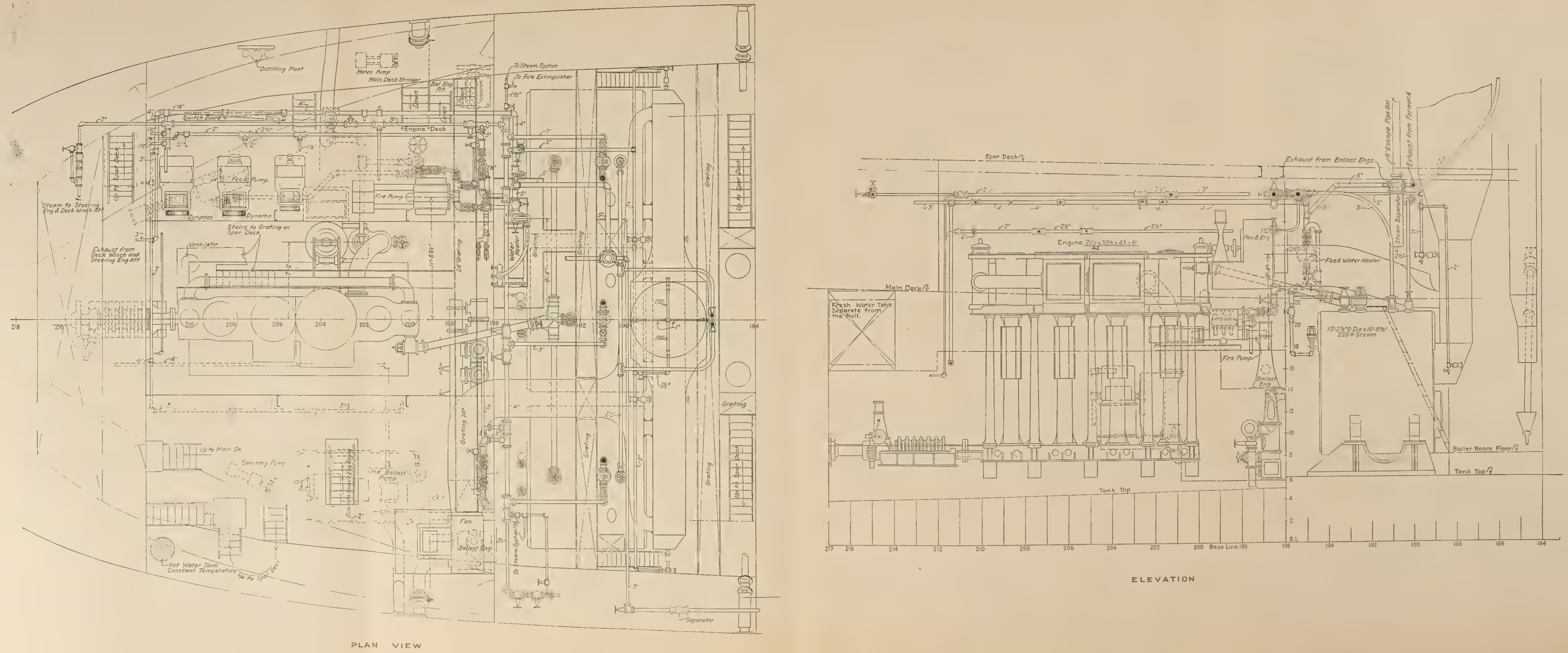


Fig. 5.—Arrangement of Machinery and Piping

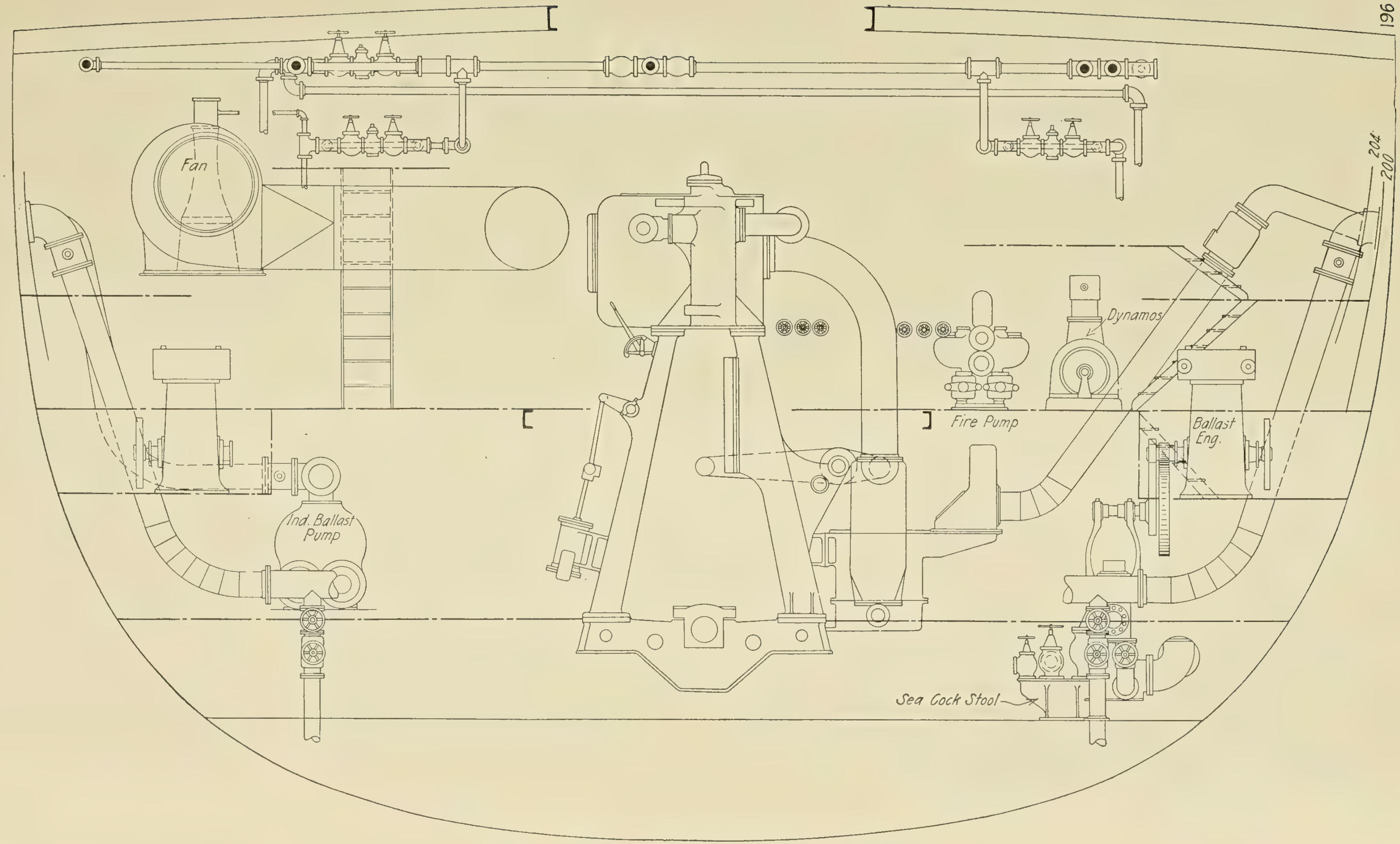


Fig. 6.—Section at Frame 196, Engine Room, Looking Aft

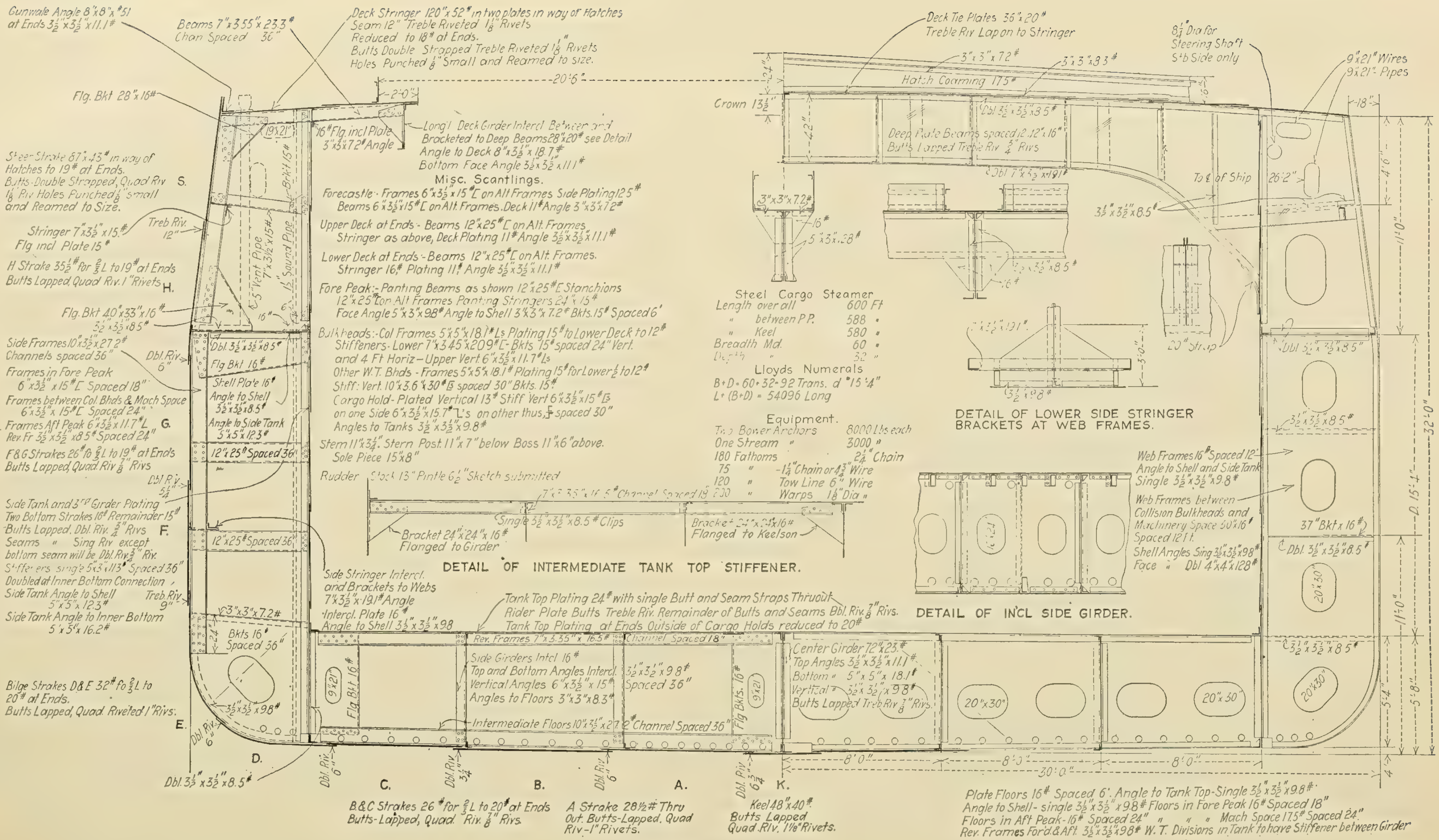


Fig. 7.—Midship Section

Two ash guns located in the boiler room, one on each side of the vessel.

Deck Machinery

One 10-inch by 14-inch spur geared windlass with wildcats of suitable size for handling 2¼-inch chain is located forward on the main deck.

Winches

Seven deck winches of the double cylinder 8-inch by 10-inch single drum type with link motion reversing gear are provided as follows:

Two located forward of hatches and two aft of hatches on the spar deck, one with gypsy head located on the spar deck at the stern of the vessel and two with gypsy heads located in the windlass room.

Four double cylinder 6-inch by 5-inch hatch winches are also provided, two being located forward of the hatches and two aft of the hatches on the spar deck.

The steering gear consists of a 10-inch by 8-inch screw steering engine of the combined hand and steam type, located on the main deck aft and operated by a brass wheel and stand fitted in the pilot house.

Provision is also made for operating the steering gear in emergency from the top of crew's deck house aft by means of suitable gear and clutches.

Ballast System

The ballast system consists of fourteen single acting trunk pumps 16 inches by 12 inches, driven by two double high pressure engines with cylinders 8 inches diameter by 8-inch stroke.

Seven pumps are located each side of the center of ship, and each pump is connected to a compartment in the double bottom or side tanks by a separate pipe 7 inches in diameter. A double manifold is fitted between pumps and the system is cross-connected by valves and fittings in a manner which will allow for filling or emptying each or all of the compartments or for pumping from any one or more compartments to any others.

Two 14-inch filling valves are provided which are located below the light waterline.

In addition to the trunk pumps a horizontal duplex ballast pump 12 inches by 18 inches by 18 inches is provided and connected to the manifold the same as the pump trunks.

All the ballast pumps discharge overboard at about the 25-foot waterline.

Drainage System

Provision is made for draining the holds and machinery spaces as follows:

Two drain valves are located in the tank top in the dark hold forward, one fitted on each side of the vessel. These valves are fitted with reach rods so that they can be operated from the dunnage room above.

The forward cargo hold is drained by a well through the after collision bulkhead with steam syphons leading overboard, the steam valves for the syphons being located in the dunnage room. Two gate valves are also provided between the forward cargo hold and the dark hold, arranged to be operated from the main deck.

A drain hole 6 inches square is located on each side of the ship in the screen bulkheads between the cargo holds.

The after cargo hold is drained by a cast iron well through the forward coal bunker bulkhead and tank top on each side of the vessel and fitted with an 8-inch suction to the ballast manifold in the engine room.

Drains from the boiler room through the bulkhead to engine room above the tank top are fitted with gate valves.

Steam syphons are also fitted in the engine room well and one on each side in the boiler room.

Ventilation

Two 30-inch ventilators are provided for the boiler room and four 20-inch vents in the engine room, all fitted with turning gear operated from below.

The crew's quarters are ventilated by 10-inch vents fitted with dampers handled from the inside.

Electrical Installation

The vessel is fitted with a complete electric lighting system and intercommunicating telephone and call bells.

An electric whistle is also provided and oscillating electric fans are installed in the captain's, owner's, chief engineer's and steward's staterooms, and the galley, dining and mess rooms.

Two 15-kilowatt and one 7½-kilowatt direct connected generating sets make up the installation.

The *Horace S. Wilkinson* is one of the largest and best appointed bulk freighters operating along the Great Lakes, and the builders and owners may justly feel proud of her.

The Outfitting Dock

BY RALPH L. PADDOCK

It is a debatable question as to just how much machinery should be installed while the hull is on the ways, and because of the lack of planning for this work it is seldom known just how much will remain to be done at the outfitting dock. Therefore the amount of work at that point will vary considerably, and when such variation occurs it hinders any attempt at a maximum output. The deleterious effect of this varying condition is also seen in hundreds of manufacturing plants where one department's output varies periodically with the succeeding department's. For when department *B* finds the supplies which come from department *A* piling up, a condition which causes *A* to slow down, it puts forth efforts to catch up. It no sooner begins to do this than *A*'s output begins to drop, and *B*, fearing a shortage of work because of its increased and *A*'s decreased output, desists from further efforts, and now with the conditions reversed another surplus begins to accumulate. This condition prevents maximum output.

To reach some conclusion as to the equipment of an outfitting dock, it must be assumed that the number of hulls launched per month is nearly constant and the amount of machinery and outfiting is about the same for each weight and type of ship. With this assumption it is possible to estimate the size and equipment of an outfitting dock which should be so proportioned to the needs of the yard that the space and machinery will at all times be occupied. Unused space bears taxes and interest the same as used space, and is a loss the same as idle or non-producing machinery.

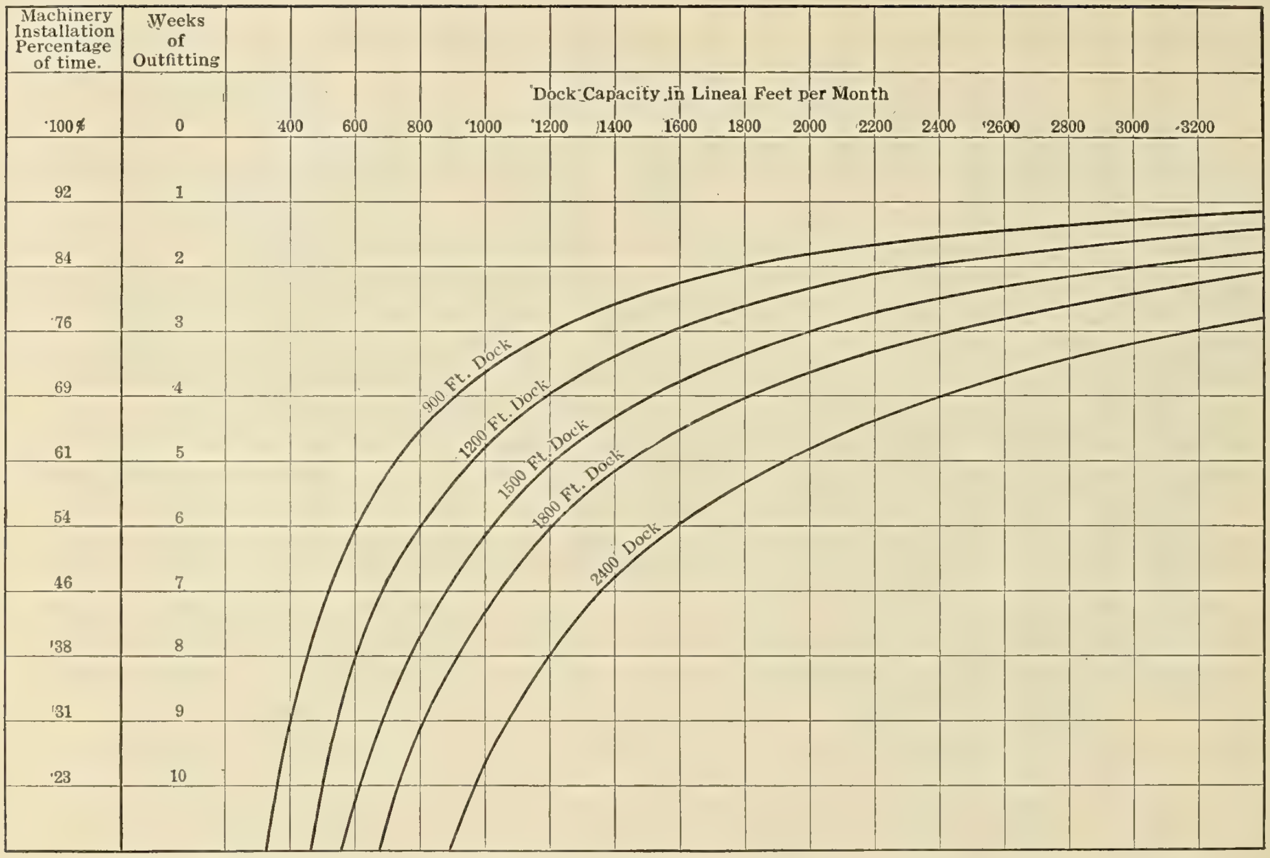


Fig. 1.—Chart Showing the Length of Outfitting Dock Required for Various Dock Capacities and Weeks of Outfitting

When the outfitting dock is already built and there is a congested condition, the question arises whether the congestion is actual or imaginary. If it is imaginary, the fault lies with the planning department in not carrying out its schedule. If it is actual, it is because of improper planning, insufficient space or equipment or lack of both space and equipment. The effect due to labor shortage is intentionally omitted, but should the shortage of dockage and equipment be the cause, it may be relieved materially by installing the boilers and engines before instead of after launching.

Launching with the boilers and engines installed is not new in this country, nor in Italy, where it was done over fifteen years ago with an end-launched ship. The installation of the heavy machinery at the ways would eliminate the heavy cranes at the outfitting dock and very likely require no heavier cranes at the ways. This prelaunching installation results in smaller outfitting docks.

The factors which govern the frontage of outfitting docks are:

(1) Length and beam of ships.
(2) Number of hulls launched per month.
(3) Number of weeks outfitting at dock.

Fig. 1 shows curves giving the length of dock for varying amounts of lineal feet of hull per month when the number of weeks required for each boat at the outfitting dock is given. The latter is also expressed in the percentage of time equally distributed from the starting to the finishing of the machinery installation. The percentage of machinery installation has generally referred to the valuation or weight of the machinery, but here it refers to time in days.

As an illustration, assume a ten-way yard launching a 10,000 deadweight ton, 400-foot ship from each way every 100 days, or 2.5 ships per month with boilers and engines already installed, and that each ship after four weeks at the outfitting dock would be ready for her trial trip. At this rate there will be 1,000 lineal feet of hull ready each month for the outfitting dock. The length of dock frontage to meet this output may be determined by referring to Fig. 1. Follow down the line representing 1,000 lineal feet of ship per month until it intersects the four weeks or 69 percent machinery installation line. Through this point would pass the 1,000-foot curve, but as it is impossible to erect one-half of a ship, the space must be sufficient to accommodate three ships and therefore a 1,200-foot dock will be required.

Could the time at the outfitting dock be reduced to three and one-half weeks, a 900-foot dock would be sufficient provided the units (the ships) were of such length that they could occupy the entire frontage. But in this case, as they are not, the dock's length must be a multiple of the unit length and remain 1,200 feet. The next reduction in length would be to 800 feet, and with this frontage each ship must be finished at the dock in about one day more than three weeks, so as to make way for those following. The total frontage may be reduced by placing the ships abreast, in twos or threes, if there is sufficient room in the wet basin, or if the property line extends far enough away from a dock running parallel with the shore line.

In a yard where the boilers and engines are installed after launching and all other conditions remain the same as those mentioned, about 43 percent of the total installation time will be spent at the outfitting dock. This is slightly more than twice as long as in the former case and would require a dock twice the length, or, as indicated in Fig. 1, a 2,400-foot dock. This length may be reduced one-half, or to one-third, by mooring the ships abreast as already mentioned.

It has been assumed that the installations will attain the same speed at the outfitting dock as on the ways. This, however, is not the case. A hull on the ways is more accessible, and of most importance is the impelling force which drives the men to work faster there than at the outfitting docks. This may be attributed to the interest manifested to have the ship launched as soon as possible. Therefore, the results attained in installing the boilers, etc., before launching will show up to better advantage than herein mentioned.

The machinery has been referred to as 43 percent installed. This percentage quite generally refers to the value or weight, whereas here it refers to the time required. For instance, the list covering the machinery installation of a 9,000 deadweight ton cargo ship may comprise as many as seventy-five items, each item representing a certain operation upon which time is expended. By summing this up it would amount to about 680 days, of which 100 are allotted to the time at the outfitting dock. This does not mean that the ship remains 580 days on the ways and 100 more at the outfitting dock, for there may be many different operations going on at the same time and the fourteen operations at the outfitting dock, were they done simultaneously, would be completed in seven days. But as not all of these require this time, the one requiring the longest time will determine when the ship will be ready for its trial trip.

Table I establishes a time relation for all the principal groupings of machinery installation. The figures under "Boilers and Engines Installed on Ways" have been taken from a planning chart, whereas those in the columns under "Boilers and Engines Installed at Outfitting Dock" are deduced from the other columns. For different yards this table will have different values, but here it illustrates the effect upon the equipment and length of outfitting dock when the boilers, etc., are installed either before or after launching. Any shipyard, however, may make up its own tables in the following manner:

(1) List all the material to be installed and set opposite each the number of days required for installation.
(2) Classify those under the headings given in the list with the days added.
(3) Obtain the daily percentage by dividing by the total and multiplying by one hundred.
(4) Figure the percentage for each item by multiplying the number of days with the daily percentage. The percentages indicating the amount of time spent on each operation before the launching and after the launching depend upon what has been planned. With these figures available the total period column may be completed.

The crane at the outfitting dock should be able to lift the heaviest single piece of machinery with ease, but since it is seldom called upon to lift these pieces, many of the valuable operating conditions such as speed and movements found in the costlier cranes may be dispensed with. From an examination of seventy-four shipyards the shear leg crane predominates.

As the remaining installations on the ship consist largely of electric wiring, piping and plumbing, a building should be located on the outfitting dock to hold the machinery for this work and provide storage for supplies. The machinery should consist of pipe fitters' machines, a machine lathe, sensitive drill presses and several wood working machines. The material stored would include pipe flanges, electrical supplies, nautical instruments and other articles. As it would be used as a service station it should have a telephone connection with the rest of the yard.

In order that locomotive cranes and supplies in quantities may be available on the dock, there should be a standard gage railroad track running the entire length of the pier and parallel to the dock whereby it may serve the entire waterfront. The dock should be well supplied with electricity and air outlets at points convenient for use on the ships.

With the outfitting dock arranged to meet definite conditions obtained through proper planning, the varying quantity of work will remain at a minimum. Also the dock will at all times have its frontage occupied with ships.

Table I.—Percentages of Machinery Installations when Boilers and Engines are Installed either on the Ways or at the Outfitting Dock

List of Materials	Total Installation Period		Boilers and Engines: Installed on Ways		Boilers and Engines: Installed at Outfitting Dock	
			Before Launching	After Launching	Before Launching	After Launching
	Days	Percent.	Percent.	Percent.	Percent.	Percent.
PIPING:						
Steam	35	5.15	5.15	....	....	5.15
Exhaust	15	2.21	2.21	....	....	2.21
Sanitary, Bilge, Service	107	15.73	14.26	1.47	14.26	1.47
PUMPS	50	7.35	6.48	.88	6.48	.88
Line shafting, bearings, propellers, stern tube	27	3.97	3.97	....	3.97	....
BOILERS:						
Uptake and Stack	36	5.29	4.32	.88	....	5.29
coverings, pipe and boiler	20	2.94	2.35	.59	....	2.94
Condenser	8	1.18	1.18	....	1.18	....
Forced draft, fan and duct	12	1.76	1.76	....	....	1.76
Evaporator and feed-water heater	21	3.09	3.09	....	1.50	1.59
TANKS, Oil, Water, sanitary	18	2.65	2.65	....	2.65	....
TURBINE	21	3.09	3.09	....	....	3.09
Generator switchboard and Lighting equipment	52	7.64	3.96	3.68	....	7.64
Steering Engine and Gear	28	4.12	4.12	....	4.12	....
Plumbing, Fittings	15	2.21	.88	1.32	.88	1.32
Deck Winches and Windlasses	9	1.32	1.32	....	....	1.32
Refrigerator set	8	1.18	1.18	....	....	1.18
Fuel Oil System	42	6.17	6.17	....	6.17	....
Engine room railing	12	1.76	1.76	....	....	1.76
Telegraph	24	3.53	.88	2.65	....	3.53
Tools and Outfit	3	.44	....	.44	....	.44
MISCELLANEOUS	117	17.20	15.43	1.76	15.43	1.76
	680	99.98	86.31	13.67	56.64	43.33

British Built Cargo Steamer Amstelland

AMONG vessels completed in British yards during the past few months are several for foreign account intended for special freight service. Of these the *Amstelland,* built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at the Wallsend shipyard was completed in August, and after a successful trial turned over to her owners, the Koninklijke Hollandsche Lloyd, of Amsterdam.

The *Amstelland* is a fine-line cargo carrier having a cruiser-shaped stern. It is designed to carry nearly 13,000 tons deadweight at a draft of 28¼ feet. She has an overall length of 490 feet and a beam of 61½ feet. The cellular double bottom is arranged for either oil fuel or water ballast. The propelling machinery and boilers were built at the Neptune Engine Works of Messrs. Swan, Hunter & Wigham Richardson, Ltd. The boiler unit consists of five cylindrical boilers designed for a working pressure of 200 pounds per square inch under forced draft and fitted for burning either oil or coal. The boilers are also equipped with Robinson marine type superheaters. The propelling unit consists of a set of double reduction gear turbines of Westinghouse-Rateau type driving a single propeller.

Two of the holds in the ship are refrigerated for carrying frozen meat. The three other holds of the vessel are for general cargo.

The Functions of the Merchant Ship*

Basic Factors Upon Which the Usefulness of a Ship Depends—Where Time Can Be Saved in Delivering Cargoes

BY SIR NORMAN HILL, BART.

A SHIP is a wasting property; its life is limited to, let us assume, twenty-five years, and at the end of that time it passes into the hands of the ship-breakers. It will then cease to be a ship and become merely a mass of material which has been wrought for one purpose and which can be applied to other purposes only by the expenditure of considerable labor. It follows that the economic value of the ship to the shipowner is represented by the sum of the excess of freights over payments which begin from the time the keel is laid down to the time when the vessel passes into the ship-breaker's hands; and to justify the expenditure the freights received must not only cover working expenses and provide a reasonable return on the capital employed, but they must also be sufficient to replace that capital. The freights are earned in return for the services rendered in delivering all the cargoes that are carried during the ship's life, and therefore the economic value of the ship to the shipowner is determined *first* by the total number of freights earned, that is, by the total number of cargoes delivered, and, *secondly*, by the total cost incurred in delivery of those cargoes.

To oversea commerce and to the interests of the producers and consumers in the world which that commerce serves, the economic value of the vessel is determined by the same factors, but while the shipowner is concerned with the sum of the excess of freight over payments, the producers and consumers are primarily concerned with the sum of the cargoes delivered. Cost of transport is no doubt of importance, but it is relatively a small matter compared with abundance of supplies in relation to demand.

Regarded, therefore, from the point of view of the shipowner, the producer and the consumer, the one and only function of the merchant ship is to deliver cargoes and delivery connotes:

1. Loading.
2. Transportation in safety.
3. And discharging in good condition.

What cargoes are to be delivered and through what ports such cargoes are to pass is determined by the flow of overseas commerce, which is in the main governed by the needs of the consumers. Those are matters over which the shipowner has no control—it is for him to satisfy the needs as they arise.

As oversea commerce is now carried on, a ship spends about one-half of its life at sea under steam and the other half in port, engaged in loading and discharging and in overhauls and repairs. The time spent by the ship in port has been described as lost time, but that surely ignores what is the function of the ship, which is to deliver cargoes at the points at which they are needed, not merely to carry such cargo about on the sea. It follows that the loading and discharging are just as necessary as the transportation of the cargoes, and the time occupied in each of these necessary operations must be reduced to the minimum if the maximum number of cargoes is to be delivered. Thought should not be concentrated on the saving of time in only one of these operations. The overall efficiency of a ship is therefore composed of several factors, and after safety the most important of all is time, because in measuring efficiency it is the life of the ship and the sum of the cargoes she will carry during that life that must be always kept in view.

Now in what way can the science of the naval architect best contribute to this overall efficiency?

Safety comes first. What oversea commerce needs and is ready to pay for is delivered cargoes; it profits nothing from lost cargoes. Loss is waste, whether it falls on the merchant, the shipowner or the underwriter, and it has to be paid for ultimately by the consumers.

Very careful consideration has been given to the factor of speed and its relation to the cost of its production and the cargo holding capacity of the ship. I speak subject to correction, but it would appear that on balance little is to be gained from increasing the speed with which the voyage is made. Certainly, looking back over the last thirty years, there has been but a small increase in the average speed of the steamships of the British mercantile marine. The average speed of all steam vessels belonging to the United Kingdom, including both those above and below 12 knots, was, in 1894, 10.4 knots, and in 1908, 11 knots. Taking all the available information into consideration, I do not think that the average speed of the steamships of the British mercantile marine has increased during the last thirty years by more than about half a knot. If time is to be saved it must, I think, be in port.

In designing the most efficient discharging and loading appliances for the ship, such as winches and derricks, much has been done. In designing vessels capable of loading and discharging with the minimum of labor and in the shortest possible time, particular classes of cargo, such as oil in bulk and coal, much more has been done; but in many ports the ship's appliances do not play an important part in the loading and discharging, and ships designed for the carriage of special commodities and no other will not meet the general needs of oversea commerce. The utmost despatch is required in all ports; the great majority of ships must be able to carry not only cargoes outwards, but also homewards, and frequently on cross voyages between the outward and homeward voyage, and the cargoes on all these voyages will never be of only one class of commodity.

In studying the problem how time in port can be saved, there are certain marked tendencies in the development of the ocean oversea trades to be borne in mind. The first is the growth in the size of the ocean-going steamship. The second is the concentration of the voyages on a limited number of ports, which has followed largely on the growth in the size of the ships. In the United Kingdom this concentration is so marked as to call for careful consideration. It will be found that 75.6 percent of our overseas imports, other than iron ore, and 78.1 percent of our overseas exports, other than coal, were in 1913 handled in twelve ports of the United Kingdom. The third tendency in the development of ocean oversea trade is the growth of parcel shipments and the decrease of whole cargoes. General trade, both import and export, is depending more

* From a paper read at the spring meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 6, 1920.

and more on the liners carrying mixed cargoes. It is shipped to meet almost the daily needs of individual importers, instead of being left for the purposes of transit in the hands of merchants.

The effect of all these tendencies is to concentrate the general ocean oversea trade on the ports which can offer the best accommodation to the bigger ships, both as regards berthing and the handling of their mixed cargoes; but all this concentration tells against the quick turn round of those ships in the big ports. It is no easy matter to keep pace with the necessities of the ships by adding to the accommodation in the big ports, and it is a still more difficult matter to increase the carrying power of the railways by which those ports are served. I cannot pretend to be able to offer suggestions as to the manner in which ships should be built and equipped so as to enable them to be loaded and discharged more quickly, but I do believe that it is in national interests an urgent problem, calling for most careful consideration. I realize that much of the work can only be done in collaboration with the ports; but working hand in hand with the ports and in especial with the big ports upon which the big ships are concentrated, cannot radical improvements be introduced? Are winches the last word in cargo handling appliances?

Design and Construction of Merchant Ships as Affected by Recent War Experience*

BY PROFESSOR J. J. WELCH, D. SC.

When, during the late war, the enemy adopted the policy of torpedoing mercantile vessels, the Board of Trade commenced an investigation into the circumstances attending the damage or loss of such vessels by mine or torpedo, with a view to determining whether the experience so gained suggested modifications of design or details which would conduce to greater safety of life at sea. The author was asked to undertake this investigation, and some of the information gained is given in this paper by permission of the Department named.

REPORTS from captains and other officers, detailing what occurred at the time of the casualty and afterwards, were received for a very large number of ships, these reports being supplemented later by answers to a *questionnaire* sent out by the Board of Trade to any on board at the time who could throw any light on the subject. These questions, being directed to specific points, were the means of adding materially to our knowledge. Further, in a large number of cases information was obtained from owners giving particulars of form of ship, disposition of bulkheads, freeboard, metacentric height, etc., enabling a detailed analysis to be made in such cases. From the mass of information available it is possible to arrive at some general conclusions as to subdivision and to suggest modifications as to details.

One point brought out by this analysis is the reasonableness of the figures for permeability suggested by the 1914 Bulkhead Committee. Thus in nearly every case when analysis based on these permeabilities showed that a vessel damaged in machinery or cargo spaces should float or sink, the analysis was confirmed by experience. Moreover, when analysis in connection with general cargo spaces showed that the vessel should have just floated, or should just sink, the actual results have been in accord. In other cases of damage to cargo holds, analysis based on 60 percent permeability showed that the vessel should have sunk, whereas, in fact, she remained afloat. In such cases, however, the cargo was not of a "mixed" or general character, but of homogeneous nature such as grain, which is known to have a lower permeability than 60 percent, and the discrepancy mentioned was thus adequately accounted for.

Damage Caused by Torpedo or Mine

As to the nature and extent of damage caused by a torpedo or mine, when a vessel is struck in way of a cargo hold, the hatches are usually blown off, and as the hatchways are of considerable size, the relief of the pressure set up by the explosion must be very great, tending to minimize the damage below. It seems probable, although the evidence does not justify dogmatism, that as the hatchways in large and fast steamers are often relatively small, the pressure would not be relieved so quickly in such vessels as in others, and increased damage below and to decks, as compared with purely cargo vessels, is likely to result. The irregular holes blown in the side or bottom plating varied greatly in size, and, in cases where holds were empty, or nearly so, splinters of plating, rivets, etc., were likely to be driven through the opposite side and the boundary bulkheads of the compartment attacked. Pump suction pipes leading to other compartments have often been fractured, and pipe, communication and shaft tunnels passing through mined or torpedoed compartments have been damaged, thus opening other spaces to the sea. The average size of hole for both torpedo and mine damage may be taken as about 30 feet by 20 feet. From this it follows that to make a vessel reasonably safe against attack from a single torpedo or after striking a mine, the ship should be capable of remaining afloat with any two holds open to the sea, while the minimum length of hold should be not less than, say, 40 feet to 45 feet, so as to avoid the possibility of two bulkheads being injured at the same time. These conditions can be conveniently arranged for in a vessel of about 450 to 500 feet in length.

The first effect on a damaged ship was to produce a heel temporarily to the damaged side, due to the influx of water on that side, which heel was eliminated or reduced as the water became uniformly distributed across the ship. In some cases the loss of metacentric height due to the loose water admitted to holds was sufficient to render the ship initially unstable, and heeling resulted from this cause, such heeling being diminished, or the ship even regaining the upright, as the water in the holds reached the level of the water outside. This follows from the well-known fact that the loss of initial stability is gener-

* From a paper read at the summer meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 6, 1920.

ally greatest when the quantity of water admitted is relatively small. Treating the question as one of loss of buoyancy, with constant displacement, the position of C.G. of ship remains fixed throughout, while the variation in location of metacenter depends upon the rise of the center of buoyancy and the length of B.M. At an early stage of the inflow the position of C.B. remains practically unaffected, while the diminution in the length of B.M. is given by $\frac{\mu i}{V}$ with the usual notation, μ being the fractional permeability of the damaged compartment. The value of i, the total moment of inertia of water plane area in damaged compartments, is more or less constant at all heights, and hence the loss of G.M. may be considerable in the early stages, and less important as the water rises in the compartment and so raises the position of the center of buoyancy of ship. For this reason it is more important to have watertight doors low down in the containing bulkheads of damaged compartment shut at the time of the casualty than similar doors at a higher level. The final result may be the same, but by confining the longitudinal extent of the free water low down, the ship may continue upright, and if the ship has ultimately to be abandoned, the upright position will facilitate the getting away of the boats and so conduce to the saving of life.

Out of the total number of cases examined, only some six or seven were stated to have capsized, although these included some important vessels, and of these, one was attacked by torpedoes, shells and bombs, while another was hit by two torpedoes. A fairly large number of ships are said to have retained a list, either "slight" or "heavy," after damage, most of these being in a "light" or lightly laden condition. In the large majority of cases, however, there is no hint of permanent list, and the vessels regained the upright after damage. As to the possibility of listing in the "light" condition, it will be remembered that many vessels of relatively fine form have very moderate metacentric heights in that condition, so that the loss of stability due to the inflow of water, mentioned above, might well suffice to give a negative G.M. with consequent heeling; in one case, indeed, the loss of stability due to this cause was so great as to result in the capsizing of the vessel. On the other hand, vessels of full form, carrying their breadth well down, often have very large metacentric heights when light, and many such vessels in this condition have continued to float upright with two or more large compartments flooded.

Generally, of course, after damage the mean draft of a vessel is considerably increased, but in the case of laden oil carriers the vessels remain at about the same draft as before, if struck in way of the tanks. In such vessels the machinery space is usually aft, and if the engines and boilers are in one compartment, a laden vessel is likely to sink if struck aft. This points to the desirability of fitting a watertight bulkhead between engines and boilers in these otherwise well-subdivided vessels.

Conclusions

A consideration of nineteen cases cited in the paper, and of the many others analyzed, prompts the following conclusions and observations:

1. Many ships after damage remained afloat and reached port, so it is clear that in these cases the watertight subdivision was sufficient under the actual conditions as to lading.

2. Remembering the considerable longitudinal extent of the damage from mine or torpedo, the damage from such causes to a small ship is more likely to be fatal, on the average, than that resulting from collision; whereas for large ships, capable of floating with two adjacent compartments opened to the sea, the maximum direct damage from mine or torpedo represents the maximum effect likely to be caused by a collision blow in the region of a bulkhead, and such vessels should survive. Some of the large vessels which were sunk were not so well subdivided as recommended by the recent Bulkhead Committee. Had they been so divided, and had doors and sidelights been closed, such vessels would have continued afloat.

3. It is clear, from the cases cited, that many large vessels did not survive damage from a single mine or torpedo, and the reasons for this, acting singly or in combination, were:

(*a*) Watertight doors were open, which were not, or could not be, closed after the casualty, thus giving water access to compartments not directly affected by the explosion.

Among the causes likely to prevent or render inoperative the closing of doors after the casualty may be mentioned: distortion of bulkheads caused by explosion; sudden inrush of water through the doorway, coupled with delay in closing from above; presence of coal or debris washed into the doorway; and, probably, distortion of bulkhead due to water pressure on one side.

Ordinary Marine Casualties

In determining what bearing these facts may have on ordinary marine casualties, it is necessary to consider whether such casualties are likely to occur so suddenly or unexpectedly as under war conditions. It might be presumed that during a fog, or when a collision seems imminent, all watertight doors would be closed and other precautions taken to minimize risk. On the other hand, it is proverbially the unexpected that happens, and many cases might be cited where ships have received ordinary marine damage with watertight doors open. In such cases doors constitute a distinct source of danger, the causes tending to make them inoperative being similar to those mentioned above. The Bulkhead Committee recognized the possible danger of open doors and recommended that the number of openings in bulkheads should be reduced to the minimum compatible with the design and proper working of the ship; they also suggested regulations for assuring that the doors should be kept in thorough working order. The possibility of dispensing entirely with watertight doors on main transverse bulkheads was thoroughly discussed by the committee, and the possible dangers involved in doing so were considered, but in the light of subsequent experience the matter appears to deserve reconsideration, particularly as open doors may lead to the vessel listing considerably, thus making it difficult to get boats away. It would seem possible to dispense with such doors in the machinery compartments of large transatlantic liners designed to operate continually between particular ports, and in large passenger and excursion steamers engaged on relatively short runs. If in certain cases it seems particularly inconvenient from considerations of easy communication to dispense with doors altogether, it would still be desirable from the point of view of safety to fit the doors high up rather than low down in the holds. In particular, it would seem that the doors leading to shaft tunnels, where there is a minimum of traffic, could generally be done away with, access to the tunnel being gained through a watertight trunk abaft the after engine room bulkhead, as recommended by the committee of this Institution and as actually carried out in many vessels. It may be added, in passing, that the difficult problem of bunker doors would be solved in cases where oil fuel could be adopted.

(*b*) Below the bulkhead deck sidelights were left open, and these became immersed under the influence of sinkage and heel, combined in some cases with the effect of trim, thus admitting water to intact compartments.

In a large vessel there may be several hundred sidelights below the bulkhead deck, a considerable proportion of which are capable of being opened. Recent experience goes to show that with the usual organization on board ship it is most difficult to ensure that all sidelights are effectively closed, even when stringent orders have been issued to this effect.

(*c*) Suction pipes were often fractured in damaged compartments, thus putting other spaces in communication with the sea. Early experience in this respect led to a recommendation by the Board of Trade that an efficient non-return valve should be fitted at the ends of such pipes, while this Institution advised, on the same subject, that a screw-down non-return or similar valve should be fitted, to be worked from the bulkhead deck. This recommendation has been generally acted upon.

(*d*) Bulkheads and tunnels were found to be leaky through defective calking, through bolt and other holes left in the plating, and through faulty fastenings.

The complete carrying out of the Bulkhead Committee's recommendations as to inspection and hose testing of bulkheads and tunnels, and careful inspection during periodical surveys should ensure the discovery and lead to the remedy of defects such as those under consideration.

(*e*) Pipes such as voice pipes and pump suctions from hotwell were carried through bulkheads low down in holds, without valves at the bulkheads.

(*f*) Air escape pipes and test pipes were sometimes carried a short distance only above the tank top, some with and others without stop cocks or screw caps at their upper ends. At the time of casualty stop cocks have been found open and the screw caps provided have been found not in position, so that water obtained access to empty spaces. The recommendation of the Bulkhead Committee that air pipes should extend at least as high as the bulkhead deck thus appears to be a reasonable one, while it seems desirable that sounding pipes should be treated similarly.

Structural Strength of Bulkheads

4. Referring next to the subject of the structural strength of bulkheads, it was found in the great majority of ships which came into port after being damaged that the bulkheads bounding damaged compartments had stood the water pressure quite satisfactorily, and some of these were fully tested. In the cases of two or three vessels which foundered it was stated that bulkheads gave way, but in one of these the explosion occurred close to the bulkhead, which was probably strained thereby, and this would be aggravated by the severe stresses set up by the heavy weather experienced, while in another the leakage past a bulkhead occurred when the ship was in light condition, so that no question of structural strength appears to arise here. Reviewing all the evidence, therefore, it is submitted that nothing has occurred which throws doubt upon the adequacy of the scantlings for bulkheads recommended by the Bulkhead Committee. It will be remembered that that committee made tests on actual bulkheads, and, as a result, adopted scantlings somewhat in excess of previous practice, with more efficient end connections; and war experience warrants the conclusion that the scantlings so determined are sufficient for their purpose, with a reasonable margin of safety.

5. War experience has drawn renewed attention to the question of stability in vessels subdivided transversely. Previous experience and investigation had led to the conclusion that vessels damaged within their power of flotation would in general remain upright or without serious list, and this has been fully justified by many recent examples. Moreover, some vessels which capsized, and others which took a dangerous list, did so in consequence of compartments being flooded other than those necessarily opened to the sea. It is clear, therefore, that if the integrity of all bulkheads except those actually damaged by collision or explosion could be assured, the possibility of dangerous heeling developing would be reduced to a minimum.

Listing of Vessel After Damage

The liability of a vessel to list after stated damage depends upon the metacentric height at the time. If this is reduced to a small value to obtain maximum steadiness at sea, it is very probable that heeling will develop in the early stages of flooding, although it may diminish or disappear as the water within the vessel rises. In such cases no ill effects will be experienced unless it immerses open side ports, or the bulkhead deck if the injury extends above that deck; but if the damage is so great as to cause ultimate foundering, any serious permanent list would interfere with the getting away of the boats.

The metacentric height actually given to a vessel is determined by several considerations. For steadiness at sea, this height should be small; to avoid undue heeling under the influence of wind pressure, particularly in high-sided vessels, it should be moderate in amount, while a third consideration is that just mentioned, viz., that after considerable damage dangerous heeling should not result. If it could be assumed that all ports below the bulkhead deck would be closed at the time of the casualty, a reasonable standard for determining the requisite metacentric height in large passenger vessels would appear to be that it should be at least sufficient to prevent such serious permanent list as would prevent the getting away of the boats when a length of ship equal to the floodable length amidships was opened to the sea.

Reviewing, therefore, the experience gained under war conditions, it will be seen that, while it has shown that arrangements designed to minimize risk have not, for various reasons, been fully effective and that there may be possibilities of improvement in some details, the results, given the conditions actually existing, were such as might have been anticipated from previous knowledge.

Cylinder Oil Requirements*

Because of the method usually employed, and the very small quantity used, a cylinder oil that would not reach the parts or an ordinary oil that would carbonize, or one that would fail to maintain an oil film between rubbing surfaces under the conditions of operation, would not furnish lubrication.

A cylinder oil is demanded which will minimize friction and wear in the engine, at the scant feed, whereby oil troubles in the boilers are eliminated.

The specific requirements of a cylinder oil for the lubrication of valves, cylinders, valve and piston rods are:

(1) The ability to spread readily over rubbing surfaces.

(2) The ability to maintain an oil film under high pressure (high temperature) steam conditions.

(3) The ability to resist the washing effect of water of condensation in the cylinders.

(4) The quality to furnish lubrication at small feed.

(5) The quality to lubricate without sticking the piston rings and the stuffing box packing rings.

(6) The quality to separate quickly from condensed steam, avoiding oil troubles in boilers.

*From *The Compass*, published by Vacuum Oil Company, New York.

Notes on Shipbuilding and Shipping

BY "OLD SCOTCH"

Shipbuilding is looking upwards again, as the world conditions are making towards an even keel. The latest survey of the entire shipbuilding advancement in the great maritime nations discloses the fact that in spite of the thousands of new ships turned out in the feverish haste of war times, we are still not up to the normal supply with which to carry on sea traffic.

THE insatiable demands for petroleum and its products are largely responsible for another impetus to shipbuilding, both in this country and abroad. A productive capacity of over 1,000,000 barrels a day throughout the world, with a demand in excess of production, means that many more tankers than those in being and under construction must be built to meet the requirements. Every day of late there are rumors of orders for new tankers being placed in American yards. The definite contracting for six new tankers for British account in Pacific coast yards within the past fortnight shows quite conclusively that this country can compete for this particular type of ship with foreign builders. It also shows that the battle royal is on to secure control of the world's oil supply, which all must admit is rapidly dwindling and becoming a matter for most careful consideration.

Dwindling Oil Supply Makes Economy Imperative

The excess of demand over supply of this favored type of fuel brings more acutely, every day that passes, the fact that we must economize in the use of oil for marine propulsion by using internal combustion engines. If the writer can read the signs of the times correctly, we are on the eve of a great construction of motorships in this country. We are sadly behind our European rivals, but it is not too late to get into this new field, and we can profit by the experimenting of our rivals. Several of our large shipyards have been sending representatives on hasty trips to Europe to learn of the latest developments in this type of engines, and, if possible, to secure the American rights for manufacturing the most successful types here. Shipowners are becoming alarmed at the quickly mounting cost and great scarcity of oil, and are seriously considering new construction to cut down their fuel costs and delays in the delivery of cargoes.

Tax Exemptions Give Impetus to Shipbuilding

Section 23 of the Jones law, granting tax exemptions to shipowners who invest their surplus earnings in the construction of new ships in American yards, has given a great impetus to shipbuilding. Plans have already been approved by the Shipping Board for at least thirty ships to be constructed under this provision, and many more are to follow. The Board has required that such ships be classified by the American Bureau of Shipping, and it is more than possible that the owners of such exempted ships will be required to keep them insured in American companies, so long as the rates do not exceed the world rates for this kind of insurance. The object of this Governmental aid is to help build up the merchant marine in all its branches. One-third the value of a modern ship at going rates is the limit of exemption of taxes, and it must be admitted that it will be a great help to shipowners. The interest on the capital cost and depreciation of that amount of exemption will more than pay the entire crew costs of a 12,000-ton ship. This will insure success in competition with the vessels of any nation.

Another fertile source for increase in shipbuilding is Section 11 of the Merchant Marine Act, which provides what is known as the Construction Loan Fund. By the authority of this section the Shipping Board is empowered to loan $25,000,000 a year for a period of five years to American citizens who will build new tonnage in American yards. As the Board can loan up to two-thrids of the cost of a new ship, this can result in a sum of $37,500,000 being invested in new shipbuilding each year. Approximately at current rates this should result in the building of twenty 10,000 deadweight ton ships in each of the next five years, or an equivalent amount of tonnage of other sizes. As this money loaned can probably be obtained from the Government at a less rate of interest than from private sources, this proposition should prove to be very attractive to prospective shipowners. It is required among other restrictions that vessels constructed under this agreement shall be of the "best and most efficient type." This should imply that a number of Diesel-engined ships may be constructed by means of this method of Governmental aid.

The Ladies Come Aboard

The order of the Shipping Board permitting wives to accompany captains of some of the Board ships has been provocative of considerable discussion. Of course to persons familiar with shipping this is not a new proposition at all. As a matter of fact it has been somewhat of an established custom for many years. At one time captains of warships were granted that privilege under special circumstances. It can readily be seen that much discontent might be engendered among the officers of any ship on which the captain's wife was allowed to live. The logical argument would be that, if the captain's wife can sail the seas, why not let the first mate and the chief engineer take along their better halves; and then, if they are given the privilege, why not have all the officers thus favored. It might then be broadened so that any married man in the crew could take his wife along. Probably this latter concession would not add many, if we believe in the oft-repeated adage that a sailor has a wife in every port. There would, for them, be no need of this "carrying coals to Newcastle," and much hair pulling on the wharves might be saved.

This wife-carrying order coming so closely after the ratification of the suffrage amendment may possibly be a harbinger of equal rights for women on the seas, and who knows but that before many months every Yankee merchant vessel may have in its crew lists some attractive blondes and brunettes shipped for the round trip. May I not suggest that this is possibly the solution of that very important problem of how to induce American young men to follow the sea?

Americanizing Our Crews

This problem, by the way, shows great encouragement as things now exist, for Admiral Benson has recently announced officially that of the crews (not including licensed officers) of all the ships operated by the Shipping Board.

which form the greater part of the American merchant marine, fully 57 percent are now American citizens, as compared with about 10 percent in the year 1914. This speaks volumes for the efforts of the Shipping Board in Americanizing our crews. The high wages naturally attract many young Americans, and added to that many of the new recruits have had their interest in shipping aroused by serving in the Navy or shipyards during the war.

All this is very encouraging to our efforts in operating a merchant marine, and there seems to be no good reason why we should not in a year or so further increase the percentage of American citizens who will follow the sea for a livelihood. It has been said that young men in this country do not take kindly to the sea, as the bulk of our population live inland and are consequently not familiar with seafaring matters. Heredity, however, has a strong tendency to influence our habits and customs, and somewhere back in the lineage of thousands of our citizens now living remote from the coast will be found ancestors who were fishermen or seafarers in European countries, and hence the call of the sea seems to be reaping its rewards from the young men reared in farming communities.

Young Men Ambitious to Become Officers

With true American instinct it is undoubtedly the fact that nearly all of these youngsters expect to become licensed officers as quickly as possible. Such a laudable ambition is bound to result in a very high class of officers at no distant time, when normal conditions gain the ascendancy. As an earnest of this tendency one of the great New York dailies published an interview with a prominent member of one of the marine engineers' associations, in which he bemoaned the fact that the efforts of the American engineers to have the requirements of the examinations for licenses increased had not met with much success, the blame being put largely on the shipowners themselves. This seems to be a very illogical situation, if such is the fact. Shipowners, more than any others, must realize that our success on the seas depends more on highly efficient engineers than on any other class of seafarers. With the tremendous costs of fuel and machinery repairs which now exist, the best way to circumvent them is to increase the efficiency of the engineering personnel. Carelessness or lack of efficiency of the engineer on watch ofttimes results in waste of fuel and oil or in damaged conditions of machinery, necessitating very expensive repairs.

Standards for Licensed Engineers Should Be Raised

By all means raise our standards for licensed engineers in this country, and while we are about it let us have uniform requirements in every port, so that the examinations will not be conducted solely as dictated by the local inspectors. The officers of the inspection service as well as the engineers themselves all seem to be in practical agreement on this subject, so it seems to be up to Congress in the forthcoming revision of our navigation and steamboat inspection laws to bring this highly desirable state of affairs about. The engineer officers in our merchant service, as well as in the old Navy, have too long been treated as a necessary evil, and to have an efficient merchant marine they should be given every consideration in pay and comforts that are given deck officers, and then some.

Seagoing conditions in the last half century have radically changed; the sailing vessel has now nearly disappeared from the seas, and with them should go all discriminations in favor of sailing masters, and to the detriment of the new type of responsible men, the engineers. According to the latest reliable statistics, the proportion of sailing vessels in the world's tonnage is now under 6 percent, as compared with 8 percent in 1914 and 32 percent as recently as 1902. Truly this is the age of steam and motors, and the engineer should have his full due.

Oil Burning Installation of the Aquitania

Conversion of Fuel System Results in Increased Speed—General Details of Oil Storage—Pumping Arrangements—Structural Changes

THE Cunard liner *Aquitania*, which during her eight months' retirement from the transatlantic service was converted into an oil burner, is the first of the Cunard fleet to be so equipped. The work of refitting her coal bunkers, installing oil burners and the reconditioning in general was carried out by Sir W. G. Armstrong Whitworth & Company, Ltd., at the Walker yard, Newcastle-on-Tyne.

The success of the first voyage after reconditioning, on which the *Aquitania* averaged 23.10 knots from Liverpool to New York, two days' run being made at a speed of 24 knots, fully justified the expenditure that had been necessary for the work. On her return trip to England she maintained an average of 23.45 knots, reaching a maximum of 27.40 knots on a run of 129 miles in three hours. Her original contract speed as a coal burner was 23.5 knots.

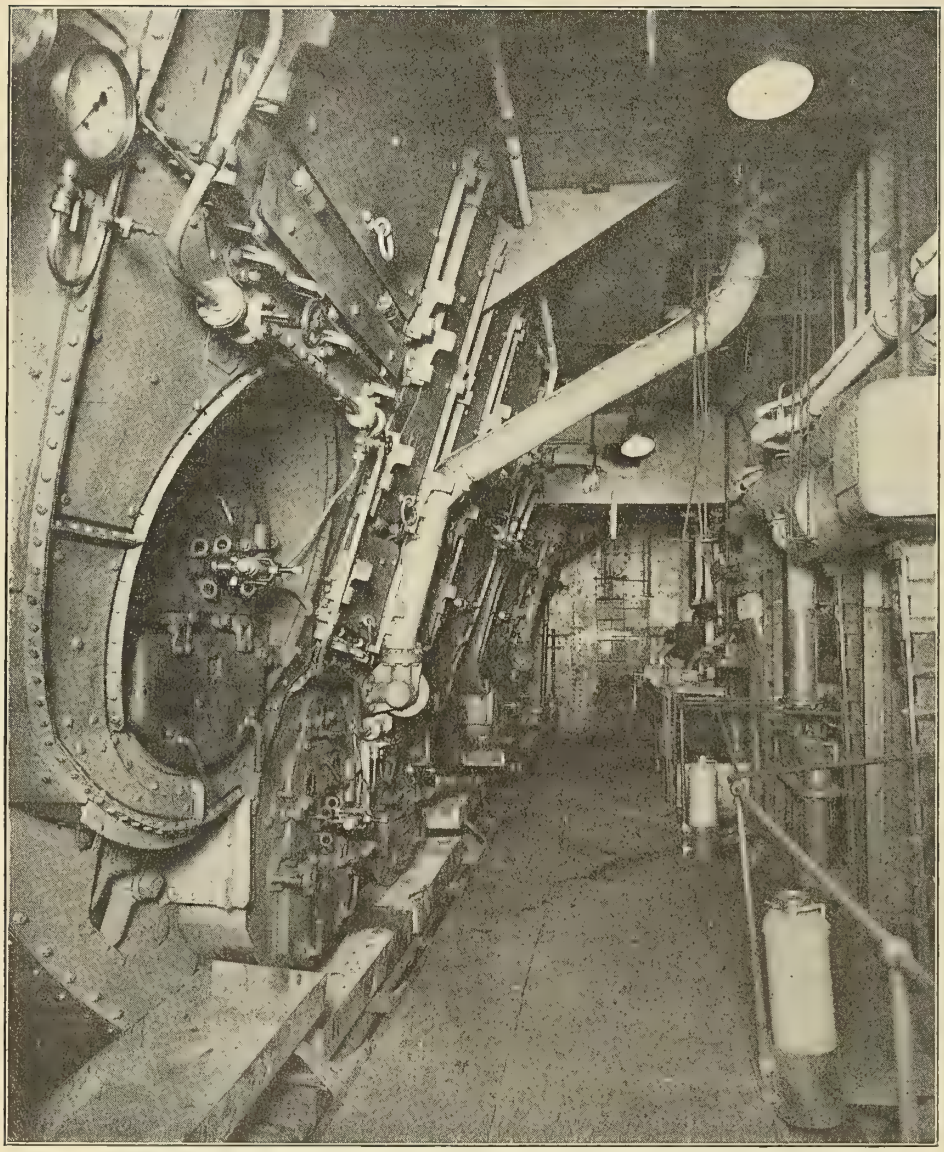
Advantage of Oil Burning Installation

The advantage most often sought in converting a ship from coal to oil fuel is the increase in cargo space made available by eliminating the coal bunkers and utilizing the double bottom for oil storage. Since the *Aquitania*, however, is not essentially a cargo carrier, and as no particular advantage could be obtained by using the double bottom tanks for storing oil, the coal bunkers of the vessel were reconstructed for fuel storage.

It may be assumed therefore that the principal advantage obtained from the use of oil as fuel in this vessel is the increased speed with the attendant economies in the boiler room. These economies are too well known to need review at this point, the single fact being pointed out that with the 168 furnaces in the *Aquitania* equipped to burn coal, assuming that 28 fires were cleaned every watch, approximately 8,000 horsepower was lost from her cruising power. The constant heat maintained by the burners in oil-fired boilers eliminates this waste, which probably accounts for the increase in speed that has been recorded.

Arrangement of Bunkers

In this ship, with a beam of 97 feet, with three large double-ended boilers arranged abreast, there remains a space of about 18 feet amidships, gradually reducing to 6 feet at the forward end of the boiler space, which formed a coal bunker on each side, and in this space, extending the full length of the boiler space, a matter of 369 feet, the oil is now carried. These side tanks do not form a continuous



General View of Single Boiler Room Showing After End of Boilers, Fuel Oil Injectors, etc.

group on each side, but are broken into two groups, port and starboard, by Frahm's anti-rolling tanks, which take up 32 feet of the length. In addition to these side bunkers, large athwartship bunkers, arranged forward of No. 1 boiler room, between Nos. 1 and 2, and between Nos. 2 and 3, have also been made suitable for oil carrying.

The large storage capacity in these side tanks and cross bunker tanks, however, did not prove sufficient to enable the ship to perform the double trip without requiring replenishing, so that six of the double bottom tanks have been made suitable for oil, to enable the 7,600 tons of oil required to be shipped at New York. Of the total quantity, 5,200 tons will be carried in the fore and aft side bunkers, 1,900 tons in the athwartship cross bunkers, and 700 tons in the double-bottom tanks. All the storage tanks, including the six double-bottom tanks, will be used solely for oil, no water ballast connections being provided. These connections are usual where double-bottom tanks are intended for oil, and involve many complications.

Reconstructing Bunkers

To make the coal bunkers suitable for carrying oil, a large amount of structural steel work has been necessary. For instance, all the bunker bulkheads have been specially stiffened, so that deformation will not occur with the weight of oil pressing against them.

All the plate joints have been specially treated, the general practice adopted being to fit stout double-riveted joggled plate straps over each plate landing, making a thoroughly oil-tight joint. Special attention has been given to plating and riveting of all steam pipe trunks and passages where these penetrate the cross bunkers. Transverse wash bulkheads have been fitted in all the side bunkers, and suitable wash bulkheads have also been constructed in the cross bunker tanks. For the full length of the side bunkers, and also round the cross bunkers, gutterways have been constructed to catch any oil which may find its way outside the tanks through leaky joints. In communication with these gutterways are bilge wells in each boiler room from which the oil bilge well pumps draw.

In the cross bunker storage tanks forward of boiler rooms Nos. 1, 2 and 3, four settling tanks have been constructed, each tank being of 60 tons capacity. In No. 4 boiler room two settling tanks of similar capacity each have been incorporated in the side bunkers, one port and one starboard. In this ship there are four boiler rooms, the three forward ones each containing six double-ended boilers, and the after one three double-ended boilers. Two settling tanks, it will be noted, are provided for each group of three boilers.

In certain parts of the boiler rooms the side bunkers overhang the wing boilers, and to ensure that there will be no chance of oil dripping on the hot boiler tops, special screen plates have been fitted in way of these overhanging parts, so that any oil which may leak through will be directed to the oil gutter below.

In addition to the special riveting which has been adopted to ensure oil-tight joints on all the tanks, electric welding has also been largely employed, with the result that a thoroughly sound and substantial tank construction has been made. The oil fuel will be burned under the White low pressure mechanical system, which has proved efficient and reliable on existing oil burning vessels.

Pumping the Oil

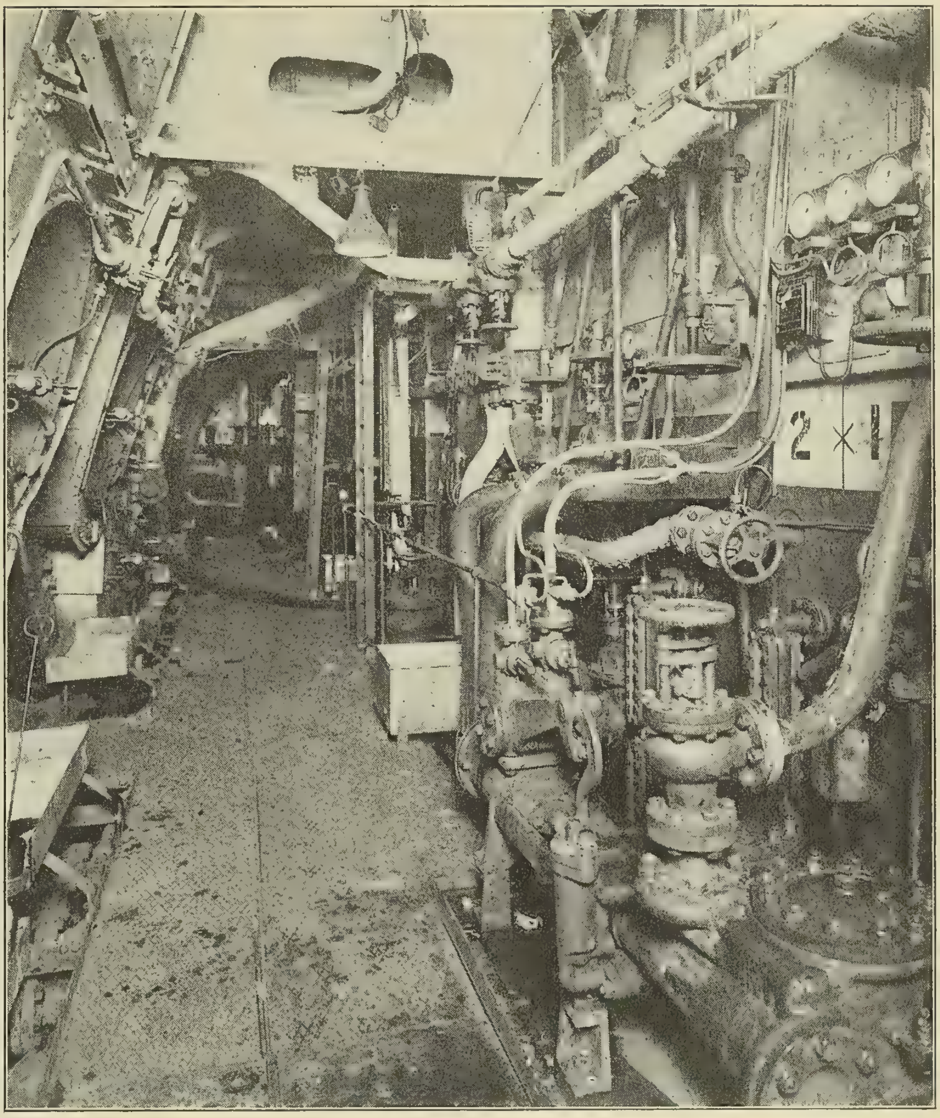
The pumping and heating plant has been supplied by Messrs. Brigham & Cowan, South Shields, and a complete installation in duplicate has been provided for each group of three boilers. In the large boiler rooms each containing six boilers there are four sets of pumping and heating plants, while in the small boiler rooms there are two sets. This ensures that only under very exceptional circumstances will the supply of fuel to the burners be interfered with through any fault of the pumping plant. The pumping and filling arrangement throughout the ship has been prepared on a substantial scale with a view to ensuring the satisfactory operation of the ship under all circumstances that can be expected.

For the full length of the boiler rooms two suction and filling mains, 8-inch bore, are fitted, one port and one starboard. In each boiler room these mains are cross-connected, and in addition suitable shut-off valves are provided, so that the system in one boiler room can be entirely isolated from any other boiler room.

Speed of Bunkering the Aquitania

Special attention has been given to the bunkering arrangements, so as to ensure that the minimum of time will be required to bunker the vessel. Each boiler room is provided with two 8-inch filling pipes from the working deck, one port and one starboard. These pipes communicate with the suction mains already referred to. Special filling compartments have been arranged on "E" deck, where the connections for coupling to the tank steamer or shore hose are fitted. These compartments are entirely separate from any adjoining accommodation, so that should any oil escape from the save-all trays which are fitted under the valves and strainers the oil will not be free to spread over the deck.

On each side of the ship there are four connections for bunkering purposes. Should the connections on one side of the ship be in use at one time it would be possible completely to bunker the vessel in about six hours. From this it will be seen that the time required in port for changing over is not likely to be determined by the fueling arrangements.



General View of After End of No. 4 Boiler Room

Storage Tanks

Precautions have been taken to eliminate the possibility of overfilling the tanks. A special arrangement of air and overflow pipes has been installed by means of which should any tank be inadvertently overfilled the oil will overflow into one of the storage tanks specially arranged for this purpose. An overflow storage tank is provided in each group of tanks in each boiler room, port and starboard. With the arrangement of overflow pipes and tanks, a sequence of tank filling must be adhered to. These overflow connections, however, are only fitted as safeguards should the other means provided for ascertaining the quantity of oil in the tanks fail.

Each storage tank is provided with a Pneumercator gage, as supplied by Messrs. Kelvin, Bottomley & Baird, Glasgow. By means of these gages the depth of oil and quantity of oil in the tanks can be noted at any time. It is usual to fill the tanks to 95 percent of their capacity, and this quantity is indicated on each Pneumercator gage. In addition to these gages, electric float alarms are fitted, so that when the 95 percent capacity level is reached a bell rings. No sounding pipes are fitted in any of the oil tanks.

To ensure that the oil will run freely from the tanks in cold weather, or when heavy oil is being used, heating coils are fitted in all the side bunker tanks and in the double-bottom tanks, but not in the cross bunker tanks, where the heating of the adjacent boiler rooms renders heating coils unnecessary.

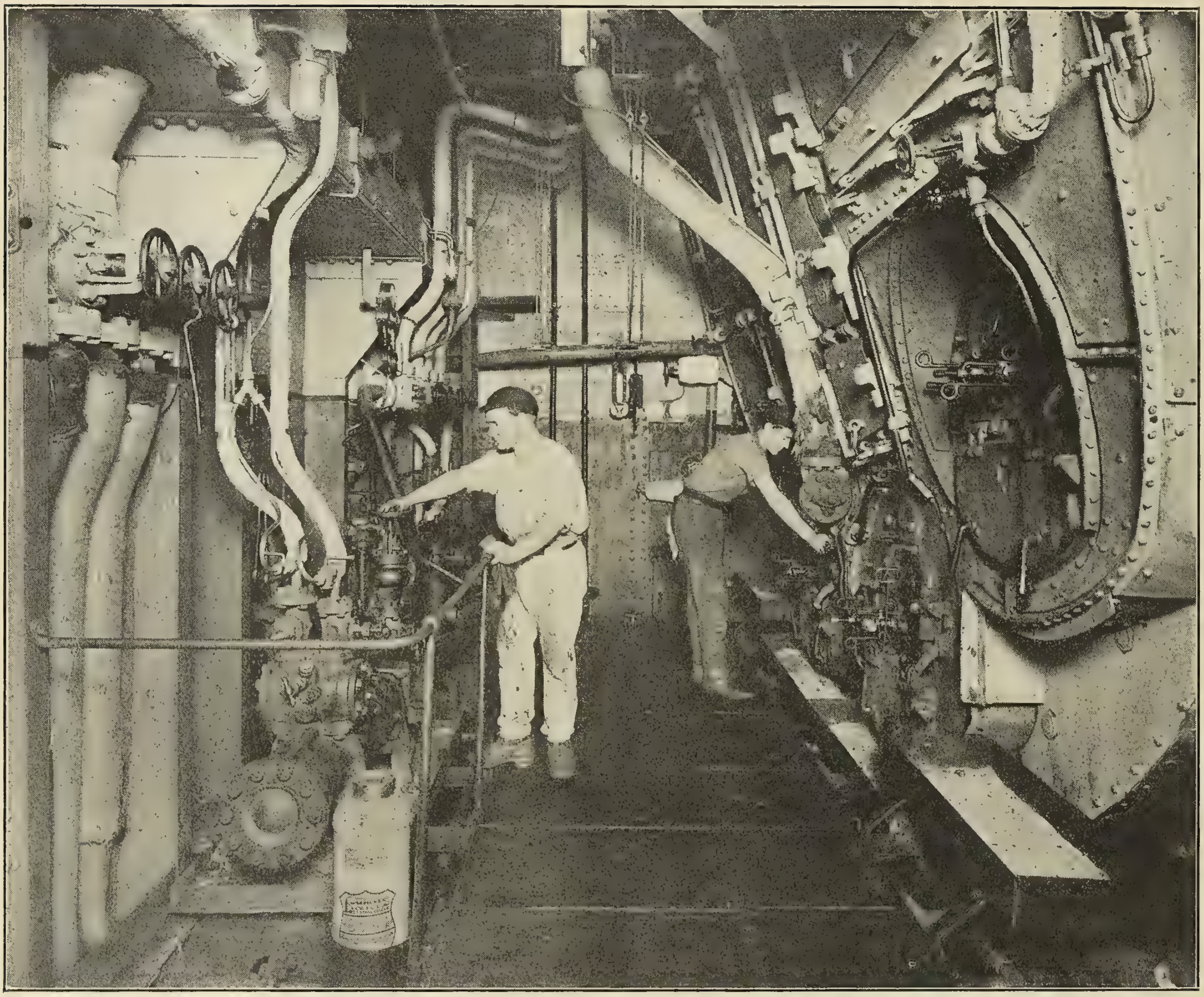
Settling Tanks

From the storage tanks the oil is pumped by large vertical direct acting pumps of Weirs' make to the settling tanks. Two of these transfer pumps are fitted in each boiler room, those in No. 4 boiler room being of 70 tons per hour capacity each, and those in the other boiler rooms of 100 tons per hour capacity each. The capacity of each settling tank is such as to ensure sixteen hours' supply for three double-ended boilers, so that about fifteen hours will be allowed for the settling of the oil in one tank while the other tank is in use.

Supplying Oil to the Boilers

To facilitate separation of water from the oil, heating coils are fitted in these tanks. Pneumercator gages and electric float alarms are also fitted to the settling tanks. The removal of the settled water from the tanks is done by the transfer pumps, which have special connections for this purpose, so arranged that it will not be possible for the pumps to draw oil from the settling tanks and discharge it overboard.

From the settling tanks the oil pressure pumps take their



Single Boiler Room, Showing Oil Fuel Unit and Furnace Fronts on Cunard Liner *Aquitania*

supply through suction strainers, discharging through the heaters and discharge filters to the burners in the furnaces. A ring main is fitted in each boiler room to which each pumping unit is connected. An emergency connection is also made to this ring main so that the pressure pumps can draw direct from the oil storage tanks. Special attention has been given to the fire extinguishing arrangement in the boiler room. With a view to speedy detection of oil on the double-bottom tank tops, a special skeleton arrangement of stokehold flooring has been fitted.

Broad working gangways have been fitted in front of the furnaces, but these gangways are kept well clear of the bulkheads, leaving an open space to view the tank top and oil gutters. No wood has been used in the construction of the flooring. The installation of the boilers has been increased, with a view to keeping the boiler temperature as low as possible.

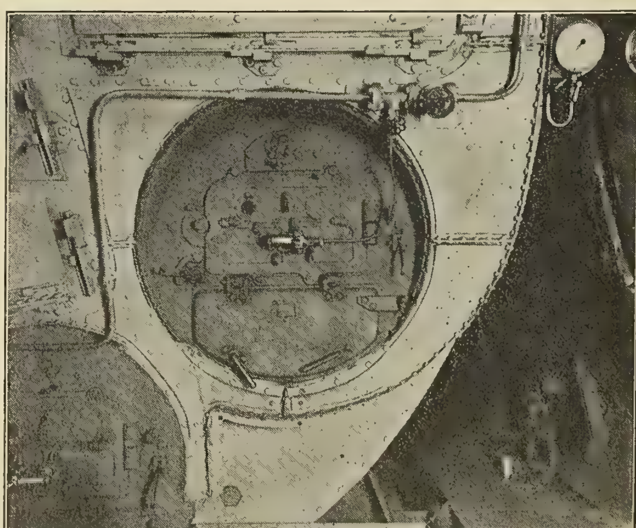
New Electric Wiring

The electric wiring of the boiler rooms has been rearranged to suit the altered conditions. The ventilation of each boiler room, auxiliary machinery room, passage, fan flat, tank tops, etc., has been very thoroughly considered. Additional ventilating fans and trunks have been fitted. For raising steam from cold boilers, a motor-driven pump is fitted in one boiler room.

Special gas exhausting nozzles and pipes with connections to the oil suction mains have been fitted to remove dangerous gases from the storage tanks before these are entered for inspection.

Reconditioning and Refitting Work

In addition to the conversion of her machinery the ship



View of Furnace Front as Fitted With Oil Fuel Arrangement has been entirely renovated and refitted. New carpets have been provided throughout the cabins and saloons and new rubber tiling for all passageways. The furniture, however, is in most cases the same as that carried by the ship on her first voyage in 1914. The furnishings have been stored in the company's warehouses since that time and have in no way deteriorated; in fact, it would be impossible to replace them at the present time.

Among the improvements that have been effected, a bank and information bureau have been installed in the reception room opposite the restaurant on "D" deck. To the swimming tanks and gymnasium have been added a sunbath room. The staterooms on the boat deck have been converted into one-berth rooms, each fitted with a bed and settee, and the whole of "C" deck amidships has been entirely rebuilt. The staterooms have been enlarged, this result being obtained by reducing the original accommodations to thirty-two rooms. Many of the staterooms now have private dressing rooms.

Panama Canal Shops Rebuilding the Steamship Marne

THE 9,600-ton steamer *Marne*, which was sunk by submarine fire in the harbor of Cristobal, at the Atlantic entrance of the Canal, on January 24 in order to extinguish a fire in her cargo of oil and gasoline, has been raised and discharged and is being rebuilt at the Balboa Shops of The Panama Canal.

The use of the submarines to sink her was resorted to because of the intense heat aboard, which made it impossible to open the seacocks. After the fire had been extinguished and the ship raised, a second fire broke out, with a violent explosion, while she was being discharged at dock. It was necessary to beach her again in order to put out the second fire.

The submarine shots, double scuttling and explosions naturally made necessary a considerable amount of repairs. These are being directed toward restoring the *Marne* to the condition in which she was prior to the first fire. Figs. 1 and 2 show how the vessel has been stripped down in the process of reconstruction.

The engines and auxiliary machinery have been taken out and are being overhauled. The deck structure amidships has been entirely removed, and a great deal of the material is being salvaged for replacement. Fig. 1 shows very distinctly the holes made by the submarine shots in her stern. Fig. 2 was taken from the forecastle, looking aft, and shows how thoroughly the upper part of the ship has been stripped. The engines had been lifted out by the 50-ton wharf crane at the time this photograph was taken.

Fig. 1.—Stern of Steamship *Marne*, Showing Effects of Submarine Shots

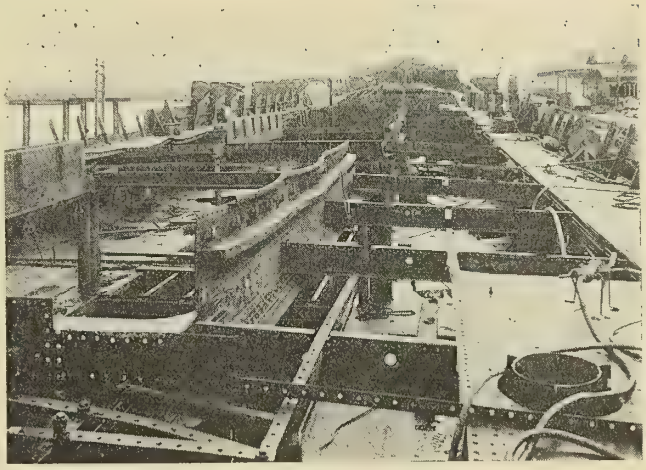


Fig. 2.—Steamship *Marne*, Showing Damaged Plates and Beams

Fruit Steamers Hibueras and Nicarao

(*Concluded from page* 803.)

One 12-inch diameter ventilator to galley.
One 8-inch diameter mushroom ventilator to all passenger and officers' staterooms.
Two 24-inch diameter ventilators to fireroom.
Four 20-inch diameter ventilators to engine room.

Lifeboat Equipment

The steamers carry on the boat deck two metallic lifeboats, 26 feet by 8 feet 2 inches by 3 feet 4 inches, with a capacity of 420 cubic feet, or 42 persons each. These lifeboats are operated with Welin patent davits and Raymond releasing hooks.

On the top of after house there is stowed a wood workboat, round bottom, 16 feet by 5 feet by 2 feet, suspended on round swan neck davits; and a captain's gig, also of wood and round bottom, 18 feet by 5 feet 6 inches by 2 feet 4 inches and suspended on round swan neck davits.

Steering Gears

A steam steering engine of the Hastie type, 6 inches by 6 inches, with extended barrel, is located on the shelter deck inside of the after end of the midship house.

An auxiliary screw hand steering gear is fitted directly over the rudder stock on the shelter deck, the steering wheel being 6 feet in diameter.

Capstan and Windlass

A steam capstan of Hyde design, with warping drum, is located on the stern for warping the steamer. The capstan has a 6-inch by 6-inch engine, with a large gypsy head of 16 inches diameter.

A steam brake windlass is fitted forward, with wildcats suitable for 1 9/16-inch stud link chain cable.

A complete heating system has been installed embracing all living quarters. All the steam heating apparatus and plumbing fixtures are modern and thoroughly up-to-date.

The dock trials and trial trips of the *Hibueras* and *Nicarao* were conducted to the entire satisfaction of the owners and their agents, William Gardner & Company, of New York, and the results of all tests were very gratifying to the builders. The steamers were constructed to burn either coal or oil, the *Hibueras* having left the yard burning coal, while the *Nicarao* sailed with oil as fuel. Immediately upon their acceptance by the Cuyamel Fruit Company, these vessels were placed in the Honduran fruit trade.

Propelling Motors For Electric Drive

Types of Motors Developed by the General Electric Company for the Propulsion of Warships and Cargo Vessels

THE induction motors which the General Electric Company have developed for ship propulsion may, for the sake of convenience, be roughly divided into two classes—those designed for battleship propulsion and those for cargo boats. The reason for making this distinction is not only because of the respective sizes, but also on account of various differences in the electrical construction and operation.

The Jupiter's Equipment

The first large electrically propelled ship was the collier *Jupiter*, which was equipped with an induction motor of the phase wound rotor type, the motor being started and reversed through an externally controlled water rheostat. The performance requirements of motors that would be adaptable to battleship drive caused necessary developments and improvements over this comparatively simple type which proved highly successful for the class of work it was called upon to perform.

The two main requirements were high speed with full power and a medium speed for a maximum cruising radius. Very quick reversal power was also required, and this at full speed.

Changeable Pole Motor Developed

The result was that a changeable pole motor was developed, those on the *New Mexico, California* and the other ships having a pole changing ratio 3 to 2, taking power at full speed from both generators and at low speed from one. The winding of these motors, which are quarter phase, has the coils so grouped that a change at the terminals will give a balanced distribution for either 24 or 36 poles. Since the four motors receive power from two generators at full speed, and one generator at cruising speed, the best combined operation is with decreased voltage on the 36 pole operation.

The rotor also has some special features, designed to meet the requirements as shown by the operation of the *Jupiter*. These trials showed that the starting resistance would only be required for a very short space of time, during starting and also during reversing, to exert a maximum torque on the screw and bring it up to speed rapidly.

Battleship Motors

For this purpose the rotor of the *New Mexico* motors is built with two squirrel-cage windings, the outer, high starting rheostat, on starting and reversing, while the inner, low resistance winding, is what the motor runs on when it is up to speed. By this construction the torque advantage of the high resistance rotor is obtained with the low speed and high efficiency of the low resistance winding when the motor is up to speed.

The motors for the *California, Maryland* and *West Virginia* are different in that high resistance winding is at the bottom of the slots, while on top is the phase winding. The latter is connected to slip rings, which, when shorted, puts the two windings in parallel. When the rings are open circuited, all the current flows in the high resistance winding. On these battleships the rings are shorted by contactors mounted on the end shield of the motor, the contactors being operated from the control board.

Minimum weight was assured by the use of steel throughout in the mechanical structure. The stator frame

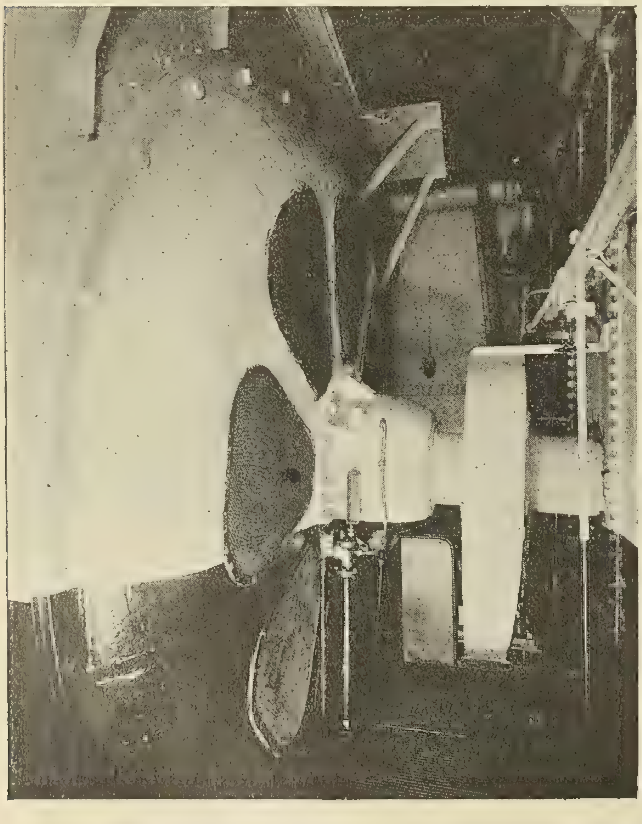


Fig. 1.—Propelling Motor, Showing Direct Connection to Propeller Shaft, U. S. S. *New Mexico*

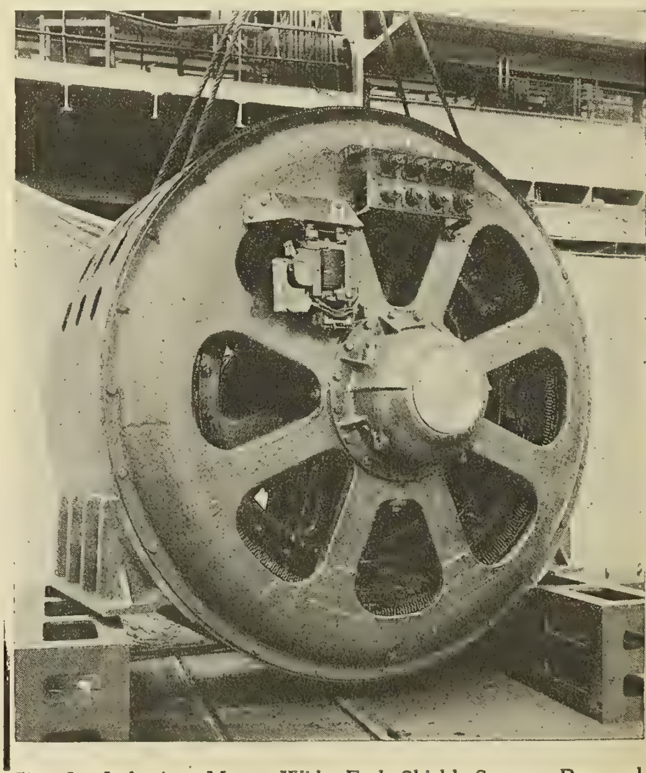


Fig. 2.—Induction Motor With End Shield Screens Removed. (Coupling End)

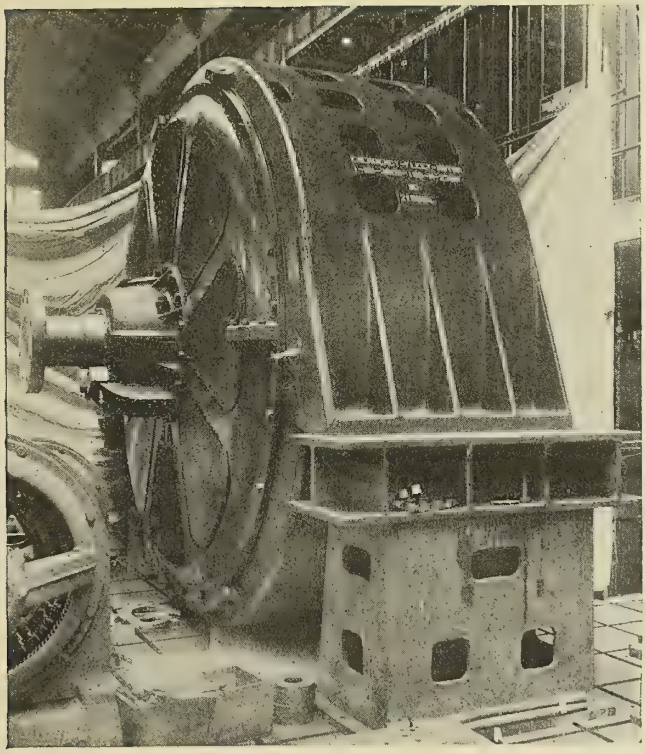


Fig. 3.—Induction Motor for Cargo Boat Drive. (Coupling End)

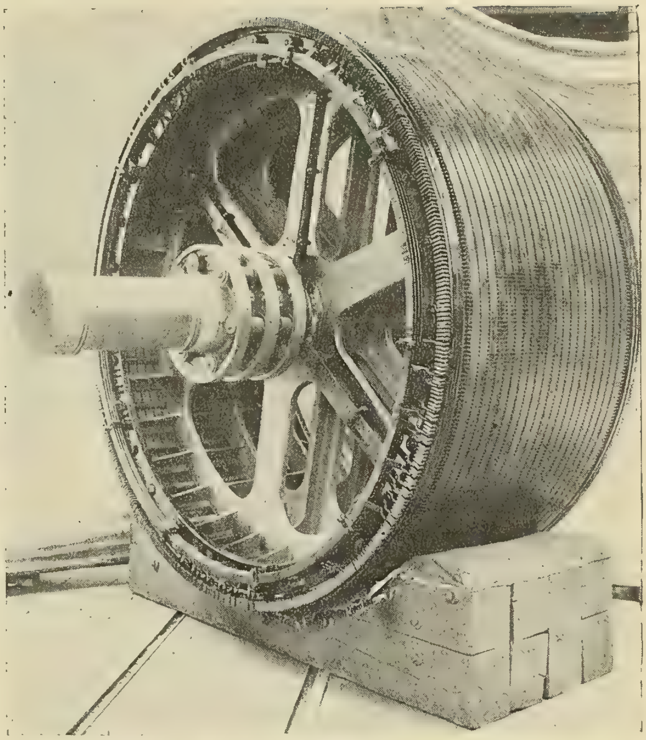


Fig. 4.—Induction Motor for Cargo Boat Drive. (Rotor-Collector End)

is made of a series of circular rings of L-beam section, each one having enough strength to support its section of punchings. Boiler plate extending the full length of the frame was rolled to fit these beams and was securely riveted to them, which gives a very rigid and compact structure. Holes for ventilation were then cut into the top of the plate. The construction of the rotor was carried out so as to have the same mechanical strength as the stator. All coils were insulated with mica and given treatment with a special varnish to resist damage from moisture and coating with salt.

Motors for the Battle Cruisers

The motors for the battle cruisers are of the same type, except that they are three phase and change poles at a ratio of 2 to 1 instead of 3 to 2. The latter ratio is an impossible one for three phase machines. Since greater speed must be developed, and consequently more horsepower, the motors are nearly twice as large on the *Iowa* and *Massachusetts* as on the *California* and *West Virginia*.

The type of motor which is used on cargo boats is an induction motor, designed for marine service, having a plain phase wound rotor with slip rings. Since starting and reversing are controlled by an external resistance, and since the maneuvering conditions such as those of battleships are not liable to arise, there is no necessity for two windings on the rotor. The pole changing feature of the battleship type of motor is also absent in these motors. In fact, they are a good deal the same as the motors of the collier *Jupiter*, which established the fact that electric drive was not only possible but highly desirable for ships of all classes.

Superheaters for the New Shawmut Steamers

In the description of the 10,500 deadweight ton cargo carriers which are under construction for the Shawmut Steamship Company, New York, at the Chester, Pa., yard of the Merchant Shipbuilding Corporation, published on page 714 of the September issue, it was stated that the steam pressure at the turbine throttle is to be 200 pounds per square inch without superheat. This statement is in error, as the Foster Marine Boiler Corporation, New York, has shipped to the Merchant Shipbuilding Corporation for installation in these two vessels eight Foster waste heat type superheaters designed to provide 50 degrees F. superheat.

Twin Screw Steamer Mashobra

THE combined cargo and passenger steamer *Mashobra* recently built by Messrs. Barclay, Curle & Company at the Clydeholm yard to the order of the British India Steam Navigation Company is the eighth of a similar type to be built by this firm for the British-India Company and is 464 feet long, 58 feet in breadth, and 36 feet in depth, with 11,000 tons deadweight carrying capacity.

Accommodation is provided amidships for about one hundred first-class passengers and fifty second-class passengers. The first-class dining saloon on the upper deck is fitted in mahogany and furnished with small dining tables in a manner similar to hotel service. At the forward end of the promenade deck are the first-class music and smoking rooms, while the corresponding rooms for the second class are at the after end of this deck. The staterooms for both passengers are quite elaborately fitted in order to give a maximum of comfort.

The cargo handling gear consists of two derricks, each of four tons lifting capacity fitted at every hatch, while a heavy derrick, capable of lifting up to 30 tons, is fitted on the foremast and a similar derrick with a 20-ton lift on the mainmast. The holds are left free and unobstructed for the stowage of bulk cargo by a careful arrangement of girders and wide-spaced pillars.

The vessel is of the twin screw type driven by two triple expansion, surface condensing engines supplied with steam from four single-ended boilers, working under Howden's forced draft, which are equipped for burning either coal or oil. The service speed of the vessel is about 14 knots.

Steam Velocities and Pressure Drop in Superheaters

BY H. B. OATLEY*

From the earliest date when the advantages of superheated steam were recognized, one of the benefits found from its use was the possibility of using much higher steam velocities in piping, steam engine cylinders, turbines, etc., with less friction and pressure drop than with saturated steam. Throughout engineering literature this point is continually brought out. All engineers versed in this field have advocated steam velocities of 6,000 *to* 10,000 *feet per minute in piping, and some highly successful power plants have been installed where such steam velocities in the piping are used. This also refers to turbine and engine designs, giving highly economical results.*

WITH the rapid introduction of steam superheaters during the past decade, it is interesting to consider how the question of steam velocities has been regarded. In the majority of installations that have been made in stationary power plants velocities of from 1,000 to 4,000 feet per minute have been commonly used. In marine installations, as well as on locomotives, higher velocities are practically universal, running from 6,000 to 10,000 feet per minute and occasionally to 12,000 feet per minute. The advantages resulting from the use of what may be termed *high steam velocities* are sometimes overlooked in the effort to obtain the lowest possible drop in pressure between the boiler and the engine or turbine. While excessive pressure loss is to be avoided, the advantages of high steam velocities are of prime importance. These advantages may be stated as follows:

(1) Prevention of scale and the deposit of fouling material on the inside of superheater units.
(2) Sustained efficiency of the superheater resulting from the clean surfaces.
(3) Increased life of units due to No. 1 and No. 2.
(4) Decreased bulk and weight of superheater.
(5) Decreased obstruction to the flow of gases resulting from No. 4.
(6) Increased capacity of boiler and sustained efficiency at the higher ratings.

Importance of Clean Superheaters

Maintaining the interior surface of the superheater units in a clean condition is of the greatest importance. The accumulation of foreign matter, or even the formation of a very thin layer of scale, greatly reduces the heat transfer and efficiency of the superheater. The steam area is also decreased under such conditions, resulting in increased loss in pressure as well as decreased superheating capacity. Where higher steam velocities are provided for, the scouring action of the steam prevents the formation of scale and the deposit of fouling material. This fact has been fully substantiated in types of superheaters which have been designed to provide velocities as high as 12,000 feet per minute. In locomotive practice the world over high steam velocities are used, and in spite of the very severe service the cleanliness and long life of these units is well known. Many of them have been examined after a period of eight or even ten years' severe service and have been found entirely free of scale or foreign substances. This condition may well be considered remarkable when the very bad water conditions commonly encountered are considered. The freedom from scale accumulation is so consistent that it is not even considered in railway service.

In stationary power plant service, however, the accumulation of scale forming material in superheaters is frequently encountered and the topic is one of first consideration in most meetings of stationary engineering societies. An extract from a report on boilers and superheaters submitted by the committee on prime movers to the National Electric Light Association in 1919 will serve to illustrate the attitude on this subject:

"It (the superheater) should be opened up and thoroughly washed each time the boiler is out of service for general overhauling. * * *

"The internal condition of superheater may be regarded generally as being a very good indicator of wrong conditions within the boiler. If the superheater shows signs of mud or scale or other foreign matters, it is time corrective means be employed to remedy these conditions within the boiler."

Difficulty of Cleaning

The cleaning of the internal surfaces of a superheater is quite difficult, because of the difficulty in obtaining access to the ends of the superheater pipes. When cores are used there is the added labor due to the difficulty of removing the cores before the cleaning of the units can be accomplished. Superheaters are usually arranged with one or more loops, and it is difficult, if not impossible, thoroughly to clean the bent portion of the unit by means of the mechanical cleaners in use. When cores are used which do not extend around the bent portion of the unit pipe the deposit of scale forming material is at a maximum in the bent portion of the pipe because of the reduction in velocity of the steam and the ease with which foreign substance in the steam may adhere to the pipe. In addition, when this portion of the unit is located in high gas temperatures, deterioration of the pipe is very rapid.

The sustained efficiency obtained by keeping the steam as well as the gas touched surfaces of a superheater free from the accumulation of foreign material is a very well-known fact, although its importance is many times overlooked. The absorption of heat by the steam from a metallic surface is affected not only by the cleanliness of the metal but by the velocity both of the steam on the one side and the gases on the other side. Increasing the velocity of the steam increases the rate of heat transfer more rapidly than an increase in the flow of the gases past the superheating surface.

Life of Superheater

That the life of superheater units will be increased by the prevention of scale, and by maintaining the surfaces in a clean condition, is a self-evident fact. The surprisingly long life of units in both locomotive and marine service, particularly in connection with firetube boilers, is conclusive evidence of the beneficial results from maintaining cleanliness of superheating surfaces by providing both high steam velocities and smooth, easily cleaned gas touched surfaces.

* Chief engineer, Locomotive Superheater Company, New York.

Decreased bulk of the superheater as well as decreased weight result from designing superheaters to provide for high steam velocities, and good practice in this respect is accompanied by a surprisingly small drop in pressure through the superheater. Superheaters with these characteristics will weigh from one-third to one-half as much as superheaters designed for low steam velocities. Loss in pressure of from three to ten pounds, when delivering from 150 degrees to 300 degrees of superheat, is commonly experienced. The advantages of decreased weight are apparent to all engineers when the conditions attending their installation and maintenance are considered. It is always necessary to inspect the interior of boilers and the exterior of superheaters at stated intervals, and it is often necessary to remove portions of the superheater in order to perform repairs and make replacements of boiler tubes and portions of the boiler setting. At such time the advantages of light and small superheater construction are apparent.

Obstruction to Flow of Gases

The obstruction to the flow of gases occasioned by the installation of superheaters has, until recent years, been given less attention than its importance warrants. The many tests on boilers fitted with superheaters have indicated that the maximum rating which it was possible to sustain has been occasioned by the obstruction due to the superheater. A decrease in the bulk of the superheater, causing less obstruction to the flow of the gases, has been demonstrated.

The increased capacities of the boiler, and an increase in the efficiency of the boiler at the higher ratings, have been demonstrated beyond question, and in some instances it has been proved that the removal of exceptionally large and bulky superheaters has permitted of an increase in the sustained high rating which the boiler could perform.

Steam Velocities

In considering the subject of steam velocities the question of drop in steam pressure through the superheater must be considered. It is generally understood that the pressure drop increases with the square of the velocity and, therefore, where high steam velocities are used a slightly higher pressure drop is to be expected. It appears, however, that the question of keeping the pressure drop down has been given consideration and discussion out of proportion to its importance.

It has come to the writer's attention that engineers have specified that superheaters should be designed for new plants with a pressure drop not to exceed 2 to 4 pounds. Why such limitations should be placed on a new boiler it is hard to understand, as the increased cost in designing a boiler, say, for 10 pounds higher pressure than would be expected at the superheater outlet is practically nil. Take a Stirling boiler with 3¼-inch tubes, for instance, and it will be noted that if the boiler were designed for 200 pounds pressure or more, which are the minimums now considered, it will be found that a No. 10 gage tube will be used. Inasmuch as the No. 10 3¼-inch tube, according to the American Society of Mechanical Engineers' Boiler Code, is good for pressures up to 276 pounds, there is leeway as far as the tube heating surface is concerned of 76 pounds without any additional cost. The only slight increase that there may be is possibly a 1/64 or 1/32 inch additional thickness in the drum, which, of course, is hardly noticeable in a new installation.

Higher Efficiency Compensates for Pressure Drop

For older installations where the margin between the maximum boiler pressure permitted and that required at the turbine, the question, of course, is of somewhat more importance, but it should be borne in mind that the increased superheat due to the higher efficiency of the higher velocity superheater for the same cost will compensate for a slightly higher pressure drop and the operator can afford to sacrifice a few pounds in pressure in order to gain the other very important advantages. In a great many existing plants it is quite possible to set the pops a few pounds higher to compensate for the slightly higher pressure drop.

In connection with the pressure drop through a superheater, it should be remembered that there is no thermodynamic loss of heat. For example, to increase the steam pressure 10 pounds from 185 to 195 pounds required only 9 British thermal units, or less than .7 percent of the total heat per pound of steam, and assuming that there is a 10-pound pressure drop through the superheater, the slight increase in the heat of the steam is not lost because it is absorbed by the steam in the form of superheat generated by the friction, which, of course, helps to raise the temperature of the steam.

Destroyer *Satterlee*. The Swiftest Vessel in the United States Navy

In her recent official trials the *Satterlee* broke all American speed records by steaming at a rate of 38.257 knots, the best previous record being 37.04 knots. She is driven by two Westinghouse geared turbines, which developed 31,223 horsepower and broke all power records for this class of vessel.

Experience and Practice in Mechanical Reduction Gears in Warships*

Extreme Accuracy of Tooth Cutting Necessary—Typical Gear Ratios in Naval Practice—Material for Pinions—Reliability and Economy Proved

BY ENGINEER-COMMANDER H. B. TOSTEVIN, D.S.O., R.N.

A difficulty in the early history of gear cutting was caused by the fact that the master worm wheel which rotated the gear wheel during the cutting operation was not quite accurate; this difficulty led to an addition to the machines of a "creep" mechanism, by means of which the job is rotated at a higher speed than the table. Any recurring error in the worm wheel which might be copied on the job being cut is, with such a machine, no longer in the direction of the axis, but is distributed in helices on the gear wheel or pinion. With improvements in the accuracy of this master worm wheel and the maintenance of the machine in good condition with all parts well lubricated during a cutting operation, the advantage derived from the use of the "creep" has been lessened, and from a list of ten firms that have cut the majority of the naval gears it is a matter of interest that on the wheel machines only four, and on the pinion machines six, firms use "creep." As regards the tendency of the worm wheel to wear out of truth, inquiry has shown that in a number of machines that have been working constantly for at least three years the accuracy has not been affected.

Extreme Accuracy of Tooth Cutting Necessary

Experience indicates that extreme accuracy of tooth cutting and the maintenance of accurate alinement are necessary to the successful operation of any mechanical reduction gear. In all naval work the turbine spindles, pinions and gear wheels are supported on rigid bearings, and the alinement is determined by accurate machine work in boring the gear housings and fitting the bearings. No gears of the floating frame type, in which the pinions and bearings are mounted in a frame supported on a flexible I-beam, which automatically maintains its correct position after being accurately alined in the first place, have been fitted, and judging from the general experience obtained over a number of years, it appears that any advantage likely to accrue from the adoption of such a system would be outweighed by its disadvantages. The important feature that must be borne in mind is that all calculations of tooth stress and dimensions of the surfaces required between the working faces of the teeth, the design and construction should be such that the total tooth pressure is uniformly distributed over the whole width of the tooth face, but various conditions arise in practice which tend to upset this working. Misalinement is one cause, and it emphasises the special care necessary in this particular. In some designs the turbines and gear cases were carried on separate supports built up from the hull structure. The turbines and gear cases as separate units are of stiff construction, and under working conditions do not suffer distortion. The possibility of relative motion between the turbines and gear case existed, and although nearly all vessels so constructed experienced no troubles with the gearing, yet in two torpedo-boat destroyers the gear became very noisy, and wear took place on the teeth. Although no actual breakdown occurred, the defects were objectionable, and the gears were removed for dressing up. When the alinement was again tested it was conclusively proved that relative displacement of the gear case and turbines had actually taken place. In later designs this movement is not possible, as the after ends of the turbines are now supported on stiff extensions of the gear case, the whole installation forming a rigid unit. This is illustrated in Fig. 15.

Owing to the action between the teeth when transmitting power, the pinion and wheel tend to increase their distance between centers. This, as pointed out, does not affect the smooth or regular action of involute teeth, but the line of centers through turbine and pinion should be free to remain parallel with the axis of the wheel, and the clearances in all the bearings should permit of this, otherwise misalinement will take place. Another cause that arises is that due to the deflection of the pinions and wheel, which in each case is of a double nature, viz., that due to the twist and that due to the bending. These points should not be overlooked in any design, but with the proportions brought about by other considerations these deflections are not such as materially to affect the working of a correctly constructed gear.

Unequal Distribution of Load

Apart from the above causes it has been observed in many gears that the load has not been distributed over the whole length of the teeth, and undesirable concentration of pressure having taken place on a portion of the length. This does not appear to be due to distortion under the twisting moment, as it has been observed at either of the ends of the pinion elements, and it has been attributed rather to an error in manufacture, the helical angle of the pinion element being slightly different from that of the gear wheel. It is necessary that particular attention should be paid to this important point right through the construction of gears, as many makers appear to be satisfied to assume that as this helical angle is a function of the machine mechanism, the angle will necessarily be correct or at least within a microscopic difference. Unfortunately, in some cases this has been found to be far from true, especially in the case of pinions, and it points to some torsional movement of the job during the cut. This may occur through strain of the driving mechanism when taking a heavy cut or a slight, slow slip of the pinion in the chuck of the machine. It appears better that nothing should be left to chance, and that the angle should be tested after the gear is cut and before the work is removed from the machine, either by again running the hob through it so as just to touch the surface or by a separate checking arrangement.

It is also to be noticed that even with an accurate helical angle of the components of the gear and correct alinement perfect contact is not necessarily obtained, as, owing to the hob receiving a certain feed for each revolution of the wheel or pinion being cut, the working face of the tooth is more in the nature of a number of facets than a fair

* Paper read before the Institution of Naval Architects, London, March 26, 1920. Concluded from September issue.

curve. This is accentuated when the teeth are shaped in a single operation, as favored by the majority of gear cutters, and the faces are often observed to have a torn or scored appearance in the direction of the cut. It is a question, therefore, both from the point of view of correcting small errors in helical angle and the formation of fairer surfaces, whether a slight finishing cut should be taken and then the hob run through again in a different relative position to that in which the main cut was taken so as to remove the high points between the facets and to smooth the surfaces that have been torn, due to the hardness of the material when taking the primary cut.

The speed of the teeth has an effect on the running and durability of the gear, owing to the intensity of shock on them. With the modern methods of cutting and manufacture, and with forged materials, the limits formerly

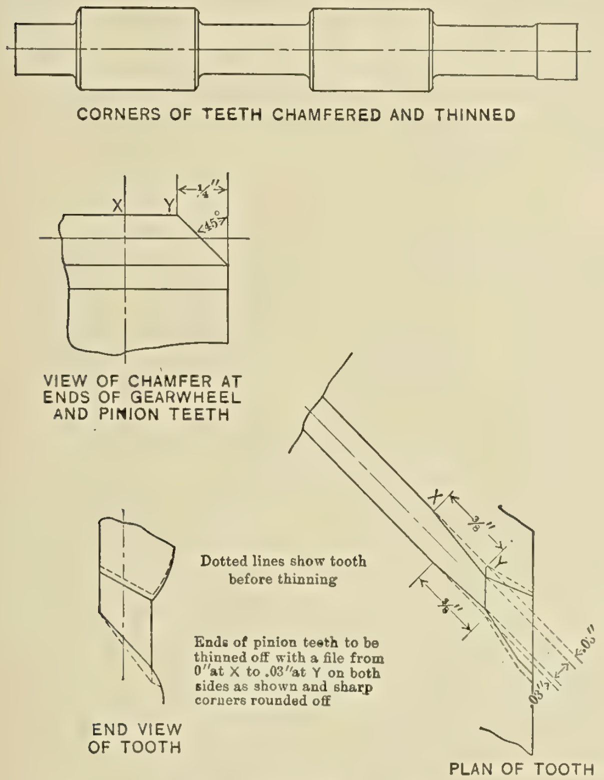


Fig. 13.—Chamfering of Pinion Teeth

used with spur gearing have been much exceeded, and there is ample experience to prove that satisfactory working can be obtained with speeds of 140 feet per second, and there seems no reason to assume that this speed could not be sensibly exceeded. The effect of the rise of temperature on the teeth, due to the rubbing contact when off the pitch line, has not appeared to be sufficient to affect the working in a well lubricated gear. In general, a gearing ratio of 8 or 9 to 1 is not exceeded in naval practice of moderate and high power.

Typical gear ratios from naval practice are given in the following table:

Type	Shaft Horsepower per Pinion		Ratio of Turbine Revolutions to Propeller Revolutions	
	High Pressure	Low Pressure	High Pressure	Low Pressure
Battle cruiser	17,500	18,500	7.1	5.2
Light cruiser	8,500	11,500	9.3	5.1
Flotilla leader	9,000	11,000	8.3	5.0
T. B. D.	6,250	7,250	8.5	6.5
"K" boat	2,250	2,250	8.7	7.7
"P" boat	875	875	11.6	11.6

In the design of a reduction gear the question of relative axial movement between the pinion and the gear wheel is of importance. This movement takes place due to the necessity of the pinion requiring to adapt itself so that the load on each element should be the same. This movement is not difficult to cater for in a single reduction, as the gear wheel being fixed by the thrust block it is only necessary to provide an expansion coupling between

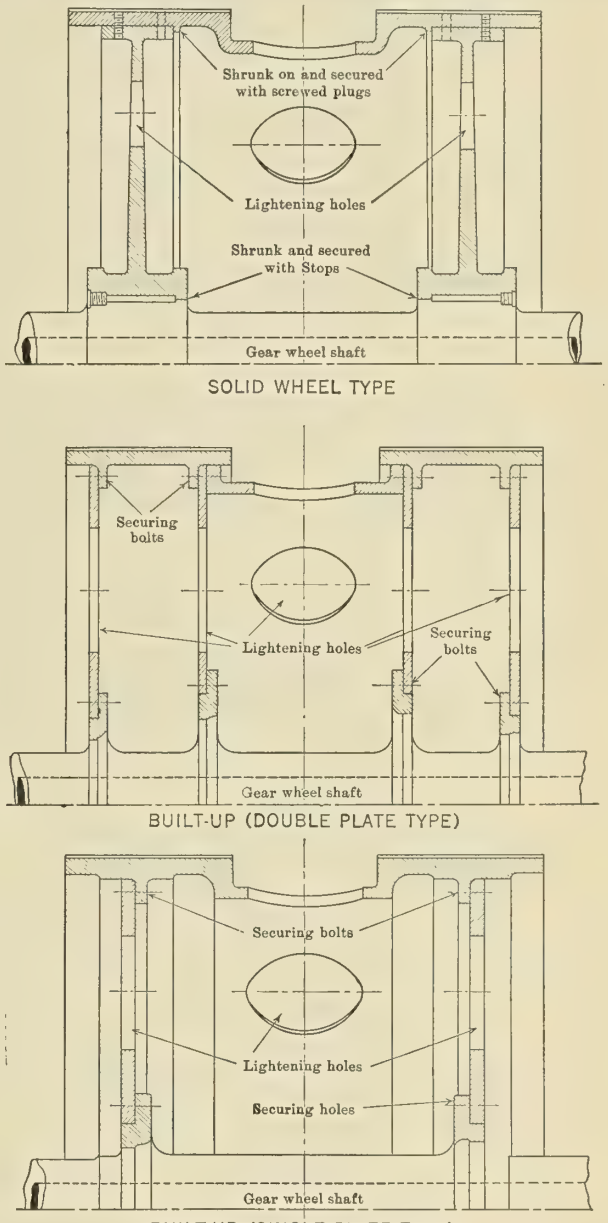


Fig. 14.—Types of Gear Wheels

pinion and turbine spindle, and allow clearance between the ends of the pinion elements and the adjacent bearings. The problem is, however, more difficult in the case of certain designs of double reduction gear, as relative movement is required between the shaft gear wheel and the intermediate reduction element, and also between the latter and the pinion. The intermediate reduction wheel being a heavy fitting, for it carries four working faces, two of fairly large diameter and two small, possesses considerably more inertia than a pinion, and in the event of fitting such a gear in warships this aspect of the problem would require careful consideration.

To avoid the same teeth of pinion and gear wheel coming in contact revolution after revolution, and also to insure uniform wear, it is usual to fix the gearing ratio so that it is not only not a whole number, but the number of teeth in the wheel and pinion have no factor in common. This is seen in Table I (see page 750, September issue).

In addition to the two cases of trouble with gearing previously referred to, there have been a few cases of failure due to the fracture of pinion teeth at their ends. This is the weakest part of the teeth, as no support is given on one side of the portion receiving the pressure. Chamfering off of the ends of the pinion teeth, as shown in Fig. 13, prevents the load coming on the extremity. Fracture of these teeth might be expected with an error in the helical angle of the components, leading to an excessive intensity of pressure at one end of an element, but cases have occurred where a fracture has taken place, and yet an examination of the gears has shown the pressure to be uniformly distributed along the length of the tooth. Seeing that under these conditions the tooth stress is low, other reasons have been sought for these failures. Of the six cases, four occurred during the contractors' trials, one occurred after two and a half months, and the other after seven months' service. In neither of the latter two cases has the defective gear been removed from the vessel, and they are still running with the broken teeth having been trimmed off and the gears dressed up.

Defective material has been indicated as the probable cause of this defect, but although careful analysis has been made, in no cases have the results indicated anything seriously wrong with the metal, although it has been noted in one or two cases that the structure has not been the best possible. It should be noted that before the vessel has been accepted by the Admiralty the teeth of the high pressure pinion in a destroyer have received their full load about a million times, and in the case of a light cruiser about 600,000 times, and the causes of failure referred to may, in the absence of any other reasonable cause, be attributed to a fatigue at a flaw developed in the alloy during its manufacture.

Materials for Pinions

The type of steel used for pinions must possess several essential qualities, viz., (*a*) strength to resist permanent deformation under stress; (*b*) stiffness, to avoid undue whip or elastic deformation when running; (*c*) surface hardness to prevent wear; (*d*) non-brittleness, so that it can stand shocks and blows.

In addition, there is the important fact that the teeth have to be cut after tempering the material, as otherwise distortion of the teeth would arise.

The specifications governing the materials for gear forgings for naval service and their treatment are given in the Appendix.

It appears that finality in respect to the most suitable material for pinions has not been reached, and it is possible in future that the use of a chrome-nickel steel with a low percentage of chromium, say from 0.3 to 0.5 percent, will receive consideration for these details in place of the nickel steel now employed. It is known that the effect of very slight variations in the percentage of the constituents, variations that may occur in different parts of the forging under the best conditions, are sufficient completely to upset the anticipated results of the heat treatment, but judging generally from experience with service gears there does not seem any pressing reason to depart from present practice.

Before a vessel is accepted by the Admiralty the gears are opened up after the full power trials and all surfaces, especially the roots and ends of the teeth, scrupulously examined with a powerful magnifying glass to ascertain whether there are any flaws or signs of cracking present that may lead to subsequent fatigue failures.

During the early running of gears on service there is often observed on the faces of the teeth an action known as pitting. Small flakes of metal are detached from the otherwise smooth surface of the teeth, leaving small hollow depressions, varying in size from a small speck to as large as ⅛-inch diameter, and 15 to 30 thousandths of an inch deep. They are most common in the region of the pitch line, where only rolling action occurs. It is difficult to account entirely for this pitting. A lack of homogeneity in the material at the tooth surface (and careful analysis by micro-photography does reveal this), or crushing of minute high spots causing failure of small sections of the metal at these high spots are possible reasons for this pitting. This action in the vicinity of the pitch line may possibly be due to the metallic contact recurring there as a result of the failure of the oil film, observing that the rubbing velocity of the teeth is gradually reduced from a maximum at the tips and root to zero at the pitch line. In any case, the action is not found to be deleterious to the smooth and efficient working, and it usually ceases after a short time.

Deformation of Teeth a Serious Fault

Deformation leading to scoring and wear of the teeth is a serious, but fortunately rare, fault in naval gears, and the only cases on service in which such wear has taken place were those previously referred to as having suffered from misalinement and in the case of a "P" boat referred to later. It has, however, taken place during the contractors' trials of at least two ships, involving removal with either re-cutting to a modified form of tooth, necessitated by the wear, or the substitution of another gear. The working is seriously prejudiced by such wear, as, apart from the reduction of life involved, it is accompanied by excessive noise and heavy "shivering" of the gear, which transmits its effects to the turbines and subsidiary fittings, causing failure of lubricating pipes, etc. Once deformation is present, or sets in, the whole face of the tooth is affected, even at the pitch line, where the contact is more of a rolling nature, as, due to the wear of the faces of the teeth, there is a tendency for the points of the harder pinion teeth to "dig in" and tear across the flank of the tooth when disengaging, the concentration of the load on the pitch line then being so great as to cause elastic deformation and a continuation of the digging in, failure of the oil film takes place, and the whole surface of the tooth is scraped away. In the two cases referred to, during trials some slight error in the tooth form was considered to have been the cause in initiating the action, being then accentuated by the consequent failure of the oil film.

From this same point of view any grinding in of the gears, apart from the practical difficulties of carrying it out, appears to be undesirable on theoretical grounds, and as it causes wear of the flanks and faces of the teeth, it leads to an undue concentration of pressure on the pitch line. A few service gears have been subjected to this operation, but it is not now being applied.

Another usual feature in gears during their early life is for a minor action of the above nature to take place, the teeth at the regions of higher pressure being rubbed away, or caused to flow so that a sharp razor like edge or small "rag" is formed on the points of the teeth. It can be stated as a general principle, however, that once these harder regions of pressure have been "beaten down," the load is more uniformly distributed and the action does not continue, nor is the working of the gear affected.

With the oils used for naval service, corrosion of the gears does not take place. Some slight admixture of water with the oil always takes place, chiefly due to steam from the turbine glands entering the adjacent bearings, but beyond a rusting effect of the wheels and pinions generally the working faces are not affected. It has been suggested that in the early life of a gear it might be advisable to use an oil carrying a proportion of graphite, from the point of view that under the working pressure the microscopic irregularities in the surfaces would be filled by small particles, and in a short time highly polished surfaces obtained. As the lubricating system of gearing is, however, common with that of the turbine installation, it has not been generally adopted, but recently this is being tried in two torpedo-boat destroyers.

From the general experience so far gained there is no reason to suppose that gearing should not have a long life, provided that a reasonable amount of care be exercised in running an installation that has successfully passed through its specified trials. Gages are supplied for testing the wear of the teeth, but as in practically all cases the wear is inconsiderable, it is not usual to keep records of this.

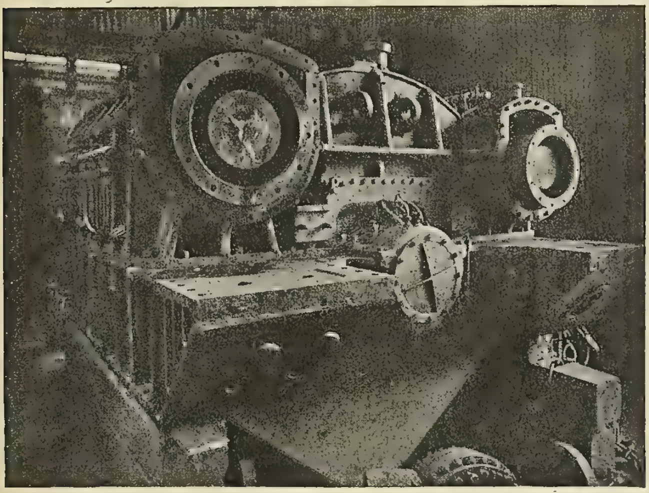


Fig. 15.—Extension of Gear Case for Support of Turbine

Proof of Reliability

Some cases of failure having been mentioned, it is of interest to sum up as a whole and see how far the anticipation of reliability has been substantiated. Of the *five hundred and fifty-six* sets of all-geared installations on service in the navy, some extending up to nearly six years, it has only been necessary actually to remove *three* for refit in the misalinement cases referred to, and here it must be emphasized that no actual breakdown occurred, and the gears, after dressing up and in one case new pinions being supplied, were subsequently re-utilized. Also in the case of one of the "P" boats the two gears had to be removed on service owing to their becoming noisy and wearing slightly. The wheels were "dressed up" and new pinions fitted. Of the cases of fractured teeth, which are two in number, the gears were not removed, the broken or cracked portions being removed and damaged teeth smoothed up. In another case a breakdown occurred through a ⅞-inch bolt, inadvertently left in the gear case, passing between pinion and wheel and damaging a portion of the length. This set was replaced by a spare, but the old wheel after cleaning up is retained as a spare with 3 inches of the tooth face out of 40 inches total missing. The failures on trials have been four with fractured teeth and two with excessive wear, and it must be admitted that these figures are most satisfactory when it is remembered that the development and experience of these gears for high powers was, except for a few cases, confined to warships.

Apart from the reduction in size of the turbines which led to more rigid and reliable units, there is a great decrease in the quantity of turbine blading required, and at one period of the war, owing to the enormous demands for copper in the munitions, etc., service generally, any question which lessened the demand for the supply of this metal or its alloys was of importance, and the reduction in blading required owing to the adoption of the all-geared installations reduced the strain on the blading makers and avoided any possible delay in the construction of warships from this cause.

Quantity of Turbine Blading Reduced

Some typical figures showing this are: In a direct driven torpedo-boat destroyer of 25,000 shaft horsepower the total length of blading sections fitted is approximately 70,000 feet as compared with 7,720 feet in an all-geared installation of 27,000 shaft horsepower. As, however, the section of the blading in the all-geared type is heavier, the weight is not in the same proportion, being as 4 to 8½ tons. Apart from the saving of fuel and slight reduction in boilers owing to the gain in economy, there is no great saving of overall weight in the all-geared installation, the gearing being a heavy fitting and helping to outweigh any saving obtained on turbines and boilers. Some typical weights are:

		Shaft Horse-power	Total weight, tons	Shaft Horse-power per ton
Torpedo-boat destroyer.......	Direct driven	25,000	372	67.5
	All-geared	27,000	393	69.0
Flotilla leader...............	Direct driven	36,000	554	65.0
	All-geared	40,000	615	65.0

Economy Substantiated

The question of economy which was one of the primary reasons for fitting reduction gearings has been substantiated. Generally speaking, the advantages of the present all-geared installations over the most recent direct drive types fitted are shown in the above table, the figures being based on the increase of the radius of action for the same quantity of fuel under service conditions, and therefore taking into account the gain in economy in the turbines and the effect of an increase in propulsive efficiency.

PERCENTAGE INCREASE IN EFFICIENCY OF GEARED INSTALLATIONS

	One-fifth power	Two-fifths to Three-fifths power	Full power
Light cruisers........	16.5	16.3	16.1 at 30 knots
Flotilla leaders.......	20.0	20.0	17.0 at 30 knots
Torpedoboat destroyer	20.0	20.0	20.0 at 30 knots

The initial steam conditions in the cases of the all-geared and direct drive installations are the same in each case.

It should also be noted in this particular that superheated steam has not up to the present been used in any all-geared turbine installation in the naval service, but with the advantages to be gained from the possible adoption in the future the smaller rigid turbines used would conceivably be more adapted for superheat than the larger direct drive units.

Review of Motorship Machinery Problems

Opposed Piston Type Engines—Novel Scavenging Pumps—Engine Room Arrangements and Auxiliaries—Diesel Electric Drive

BY HUBERT C. VERHEY

SUCCESSES obtained with single acting heavy oil engines caused engineers and manufacturers to go a step further in an attempt to approach the good points of reciprocating steam engines, so that experiments were started in Germany to produce double acting motors. This is a difficult problem in oil engine design as a stuffing box for the lower end of the working cylinder has to be used. Increased heat conditions to which the piston is subjected require special care for the cooling system. Furthermore, the construction of the lower head is special owing to the passing of the piston rod, so that the valves must be located accordingly, which invites complication. In principle, the double acting engine is ideal, and for that reason the future may have good mechanical solutions in store, as a minimum height can thus be obtained, which is of importance on board ship.

Opposed Piston Type

Engines of the Junkers type with opposed working pistons have eliminated stuffing boxes and cylinder heads, thus rendering a very simple looking working cylinder, but they are comparatively high owing to the necessity of an overhead drive for the upper piston, the movement of which is transmitted to the crankshaft by means of two long connecting rods engaging two cranks, located respectively, one on each side of a centercrank which operates the lower piston. The two outer cranks and the middle crank are set 180 degrees apart. This system offers a good balance. Two bearings are available for three cranks, thus making a long distance between the main bearings, so that the dimensions of the crank shaft, and in particular the center crank webs, must be such that care is taken of this leverage.

The fuel consumption of this type of engine is apt to be a trifle higher than the single acting two cycle engine, having a double port scavenging system, as it is not possible to start the compression stroke at a point where the available air is above atmospheric pressure.

Although the scavenging air used naturally has a pressure above the atmosphere, the advantage of this, which is utilized in the double port systems, goes for naught in this case, due to a lead required for the exhaust ports in order to reduce the prevailing pressure at the end of the expansion stroke to atmospheric pressure necessary to allow the scavenging air to enter and drive the exhaust gases out.

The same feature occurs in single acting single port scavenging engines, as the lead described above cannot be avoided and thus affects the fuel economy.

Doxford engines built in England are based on the Junker's principle and are soon expected to show their merits in actual seagoing performance in large cargo vessels. The manufacturers of these engines have also adopted the solid fuel injection system, so that their products can be regarded to represent modern practice. In the future when data obtained in actual service are available and proof has been established that the great height as compared with single acting engines of the same bore and stroke is no detriment, the opposed piston construction is bound to have a field of adoption, as considerable reduction in overall length can thus be obtained and space on board ship is an important point. For direct drive installations there is plenty of head room available in the engine room, and with adequate handling facilities and care taken for the accessibility of all parts these motors may play an important part in future developments of motorships.

Cammell-Laird Engine

England, furthermore, deserves credit for additional development of opposed piston type heavy oil motors. The Cammell-Laird engine based on the Fullagar principle embodies the Junker's type as far as the opposed piston arrangement is concerned, but in this case two working cylinders each having two pistons moving therein are placed side by side.

The respective pairs of pistons are made to act on only two cranks for the whole combination. Diagonal tie rods are provided which connect the upper piston of one cylinder to the lower piston of the adjacent cylinder and vice versa.

This means that each crank transmits the work of one working stroke and one compression stroke simultaneously, which practically makes the whole crank shaft a floating shaft, as the cranks are set at 180 degrees apart.

Two bearings are necessary to take care of the two cranks, which in turn handle all four pistons by means of two connecting rods, whereas the Doxford engine would require six cranks and as many connecting rods to transmit the work of the same number of pistons to the crank shaft.

Fullagar Engine Crosshead

A distinct departure from the ordinary reciprocating engine practice is the crosshead construction of the Fullagar engine. In addition to the usual inboard thrust of the connecting rods, this crosshead is compelled to take care of a longitudinal thrust due to the angularity of the tie rods connecting the respective pistons, a feature which has yet to demonstrate its endurance and reliability on board ship in large size engines. They have not yet been in actual service, although they are in course of construction.

Scavenging Pumps

Another novel construction is in the scavenging pumps, which are located on top of the respective working cylinders. They are attached to crossheads of the upper pistons to which the tie rods are also connected. The pumps are of the single acting type and the pistons have a rectangular shape, which, although unusual, should not fail to perform with the very low scavenging air pressures required. If the leakage of fuel gases past the upper working pistons can be prevented, the walls of the scavenging pumps and also the tightening strips which do the same work as the piston ring in a cylindrical pump may remain free of carbon and gum formation. There is a tendency, however, to draw the foul gases upward toward the scavenging pump walls due to the suction action of the piston when moving upward.

Experience has shown that the mixing of lubricating oil with foul gases gives trouble which did occur with single acting two cycle engines having a scavenging piston attached directly underneath the working piston—engines of the so-called step piston type. Leaking pistons would discharge exhaust gases past the working piston, which gases entered the scavenging pump and caused difficulties affecting the reliability of operation.

Arrangement of Scavenging Pumps

The arrangement of the scavenging pumps in the Fullagar engine has reduced the well-balanced work on the crank shaft to a certain extent and also has increased the height. In time, however, we shall have actual performance data about these novelties. It will eventually be perfectly possible to omit the scavenging pumps from the main engines by installing independent driven scavenging units, such as is now contemplated by builders of single acting two cycle engines, which can be either a reciprocating pump or a rotary blower. The independent unit would also improve the all-around scavenging process, as the amount of air required while the engine is running at variable speeds could be properly regulated.

Cammell-Laird did not adopt the solid fuel injective system, but maintained the use of an air compressor for fuel injection. The engine as a whole is a rather radical departure of prevailing practice, and it is therefore of interest to follow its accomplishments. With the same number of working pistons of the same diameter and stroke, it can be built shorter than the Doxford type, which is another step in the direction of saving of cargo space.

Cylinders

Cylinder bores up to about 30 inches are as far as manufacturers, backed by years of experience, have been able to produce good results. It is known that the larger the cylinder bore, the greater the problem and that more care has to be taken with the design and the production of suitable castings. It is one of the arguments advanced by non-believers in the future of heavy oil motors for marine use in direct driven installations.

First Cost

A real argument, however, is left in the hands of those who are unwilling at present to accept the claims of direct oil burning propulsive machinery without reserve, which is that the weights and the price of installations are high. Particularly, the price is a handicap at present, notwithstanding the undisputed fuel economy, but no manufacturer of heavy oil motors in the world has ever had a chance to compete with engines manufactured on a production basis, such as has been the good luck of steam power builders. Comparisons with steam installations are usually based on the available data of successful four cycle single acting installations, builders of which make it appear as if there is only a slight chance of introducing reliable two cycle installations. However, the advancement made in the art will be the future judge.

Arrangement

Engine room arrangements with four cycle engines have practically reached a stage where everything is more or less standardized, so that further saving in space cannot be expected. The length required does not differ much from the space occupied by geared turbine installations using oil fired watertube boilers. Large two cycle installations cannot yet be referred to in cargo vessels, although the future will surely belong to the latter type of engine, owing to the possibility of a saving in weight per horsepower and also a saving in length. The question may be raised where such installations can be found in actual service, thus forming a weapon in the hands of those strongly favoring the four cycle principle. It should not be forgotten that the European countries which developed successful four cycle installations had the backing of their respective shipowners and thus a ready market for their products. Such encouragement counts for a whole lot during the period of development, and where eventually good results are obtained it is only natural that no departure is contemplated for good business reasons. Two cycle motor builders have lacked this appreciable support.

Diesel Electric Drive

Further efforts are now being made to develop Diesel electric propulsion which tends to lead the heavy oil motor industry into different channels again. The thought is not new and the attempt is a result of experience obtained from turbo-electro installations. High speed turbines, the most economical of their kind, direct coupled to generators of moderate size, have been tried out and are in use. The thought arose to utilize the greater economy of the Diesel motor by coupling them to generators and producing current for motor attached direct to the propeller shaft. At this point a compromise becomes necessary, as the high speed Diesel motor is a different proposition as compared with the slow speed engine. There is a limit to the number of revolutions at which a high speed engine can be built, for stability and endurance and careful consideration must be given to all pros and cons.

Assuming that we are willing to sacrifice the better fuel economy of the slow speed engine for a possible gain in weight and size of the engine, we must also keep an eye open to the fact that we are adding a generator to each oil motor unit applied, in addition to the motors on the propeller shaft and all further electrical apparatus involved.

The flexibility in operation of such an installation cannot be disputed, although no arguments can be advanced against direct drive with large units as far as the maneuvering ability is concerned, as good oil motors can be handled as readily as steam engines.

It is not my intention to go deeper into the subject of comparison in this article. I feel there is a place for both schemes and no doubt the study that is being given the subject will reveal many points of interest to the maritime world, particularly in cases where we lack sufficient comparative data at present. It merely goes to prove that many different solutions are thought of, and we know that competition invariably promotes development.

Steam Installations

During recent years the economy of steam installations has also been materially improved. High speed turbines with reduction gears for the maintenance of good propeller efficiency have been built in great numbers. They had their troubles, which in the majority of cases have been overcome, merely illustrating what can be done if an actual desire to develop certain mechanical possibilities is dominating.

Turbo-electric drive is also considered. This offers the advantage of the high speed of the turbine in combination with the consequent small size of the electric generator. These installations will eventually be developed to a point of reliability as many efforts are being made nowadays which means success in the end.

It is therefore no wonder that the engineering world pays due attention to a combination of the economy of the direct burning heavy oil engine with the merits of electric machinery. The tendency is to try to bring about a suitable solution for America's problems of competition with seafaring nations to the best advantage.

There are many other angles to the whole situation, and a great field is opened for American manufacturers to bring on the market a line of auxiliaries that are the most suitable on board motorships.

Auxiliaries

Electric motors are used to run the various pumps. They are invariably of the enclosed type. Considerable study is necessary to determine the proper combination in compact units of the water and oil circulation pumps, the ballast and bilge pumps, etc. It will require the co-operation of the respective manufacturers. Up to this time the buyer of such equipment has been more or less handicapped because, as a rule, standard equipment was offered which had to be assembled to suit the standard features of either electric motors or pumps. Right here is plenty of need for improvement, which the future is sure to bring.

For some time to come, however, we may expect a period of uncertainty on the part of the manufacturer, as it is extremely hard to determine in what direction to standardize. This, naturally, will not be of direct benefit to the ready adoption of motorships, as many talking points will be raised about this handicap. American shipowners are compelled to weigh every item carefully and are mostly interested in the actual cost per ton-mile. A tendency which shows that the motorship has come to stay cannot be denied, regardless of the present handicaps.

Production will eventually flourish, as we have the shops and the manufacturing facilities, and last, but not least, the material. Two of our large concerns have built and are now trying out big engines of 2,000 and 3,000 horsepower of their own design, and from all indications they will be successful.

The world's fuel problem has become so acute that failure to look the actual situation square in the eye may mean the loss of our prestige as a maritime nation. With the limited oil supply now prevailing, machinery that conserves fuel should have a good chance to be in demand. In this way the handicap of price becomes a secondary matter, and with the extended use of heavy oil, marine engine manufacturers are in a better position to meet competitive requirements.

For ships going on long voyages the Diesel installations are the most economical and prove to hold their own regardless of the higher initial cost. Let us therefore hope that our Government, which has now been authorized by the Jones bill to finance the development of the most economical class of machinery, will give her support to manufacturers and shipbuilders who believe that the direct heavy oil burning motor has a great future.

Bureau to Modify Rules

One of our foremost institutions, the American Bureau of Shipping, can be highly complimented on their recent step of appointing a committee of experts in Diesel engine and motorship construction to revise and modernize the rules for the survey and classification of motorships. This will eventually lead to a reduction in insurance rates, which has also been a handicap to motorship development.

The greater part of America's motorships are small and equipped with hot bulb engines or gasoline motors. Both of these types offer more fire risk than Diesel installations, especially when installed in wooden hulls.

Speaking of motorships and discussing their general features, it invariably happens that comparisons are made with installations of this kind, which is by no means fair. A motorship equipped with modern engines of the straight Diesel principle does not invite fire risk and therefore may be considered as foolproof as any oil burning installation for the simple reason that all oil is stored in the double bottom of this ship, which is properly ventilated with vents leading to the atmosphere on deck. There are no external parts exposed to heat, there are no sparks flying and the oil used has a very high flashpoint—factors which have apparently been overlooked by experts who fix the insurance rates.

Comparative Trials of "Still" and "Sulzer" Engines Under Actual Working Conditions on Board Ship*

BY WILLIAM DENNY

In the year 1913, Messrs. William Denny & Brothers took out a license from the firm of Sulzer Brothers, Winterthur, for their special type of oil engines. To obtain experience in the manufacture of such engines they arranged to proceed with small twin screw engines of about 250 indicated horsepower in all and to build a hull in which these engines would be thoroughly tested. Both the hull and the power of the engines arranged for corresponded with a standard type of light draft passenger and cargo steamer, of which a number had been built for service in the rivers of India and Burmah. These vessels

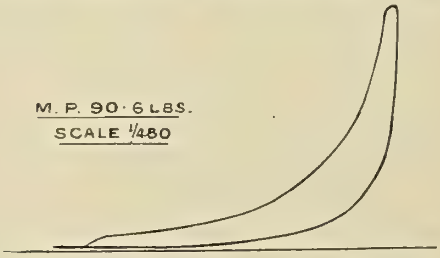


Fig. 1.—Indicator Diagram from Sulzer Engines

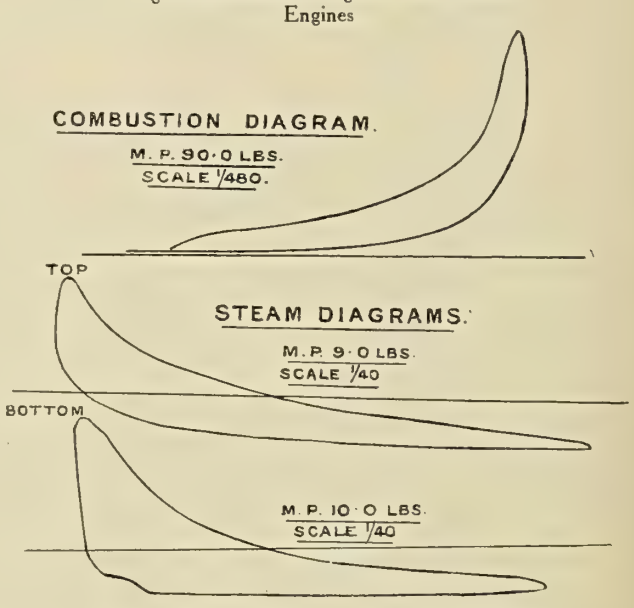


Fig. 2.—Indicator Diagrams from Still Engines

are 100 feet long, 23 feet 6 inches beam, and 7 feet 6 inches deep, and have an approximate speed of 10 knots with 250 indicated horsepower. When war broke out, the hull and engines for this experiment were well advanced, but under "control" conditions the work on them was stopped to make way for the pressing requirements of the Government.

For some time before the war the firm had been inter-

* From a paper read at the summer meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

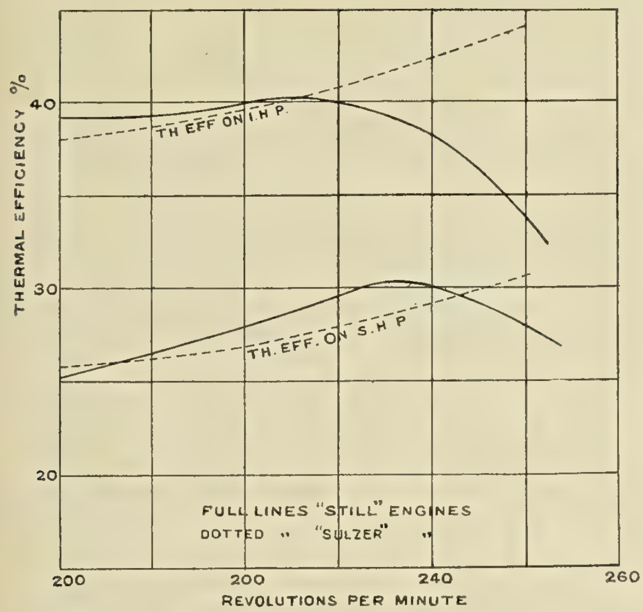


Fig. 3.—Fuel Shale Oil. Specific Gravity (.85) at 60 Degrees F. Caloric Value About 19,000 B. T. U. (Gross)

ested in the "Still" engine; fairly early in the war period it was arranged, with the consent of the Admiralty, that an experimental Still installation, to correspond with the hull already mentioned, should be proceeded with, being twin-screw engines of, in all, about 250 indicated horsepower. This arrangement was carried out and the vessel with the Still engine was exhaustively tried.

On the conclusion of the war it was decided to complete the original set of Sulzer engines and fit them to the same hull, the Still installation, so far as necessary, being, of course, removed from the vessel. This experiment also was duly carried out and the results with both types of engines are given later.

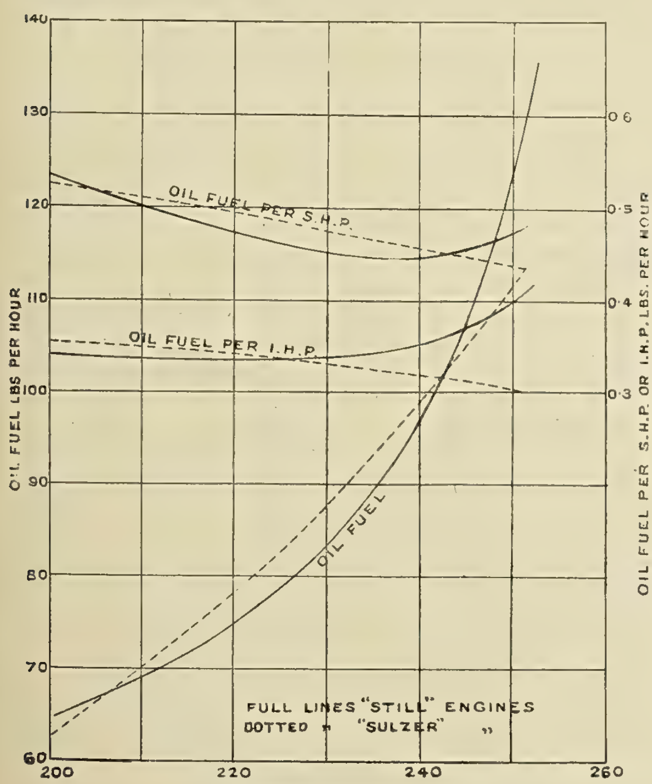


Fig. 4.—Oil Consumption

In carrying out these comparative trials, everything possible was done to ensure that the results in all respects would be reliable; the same oil was used, the same propellers, the same draft, the vessel was run on the mile to check the speed in terms of revolutions, the oil consumption trials were repeated several times, and during each trial were checked at stated time intervals, and it is considered that the results as given may be regarded as reliable.

The Sulzer type of oil engine is well known, and the Still system has been fully described in a paper read by Captain F. E. D. Acland before the Royal Society of Arts on May 26, 1919, but for the information of those who have not yet read that paper it may be stated briefly that the "Still" type of engine is a combination of the steam and of the internal combustion engine, steam acting on one side of the piston while oil combustion takes place on the other side, within the same cylinder.

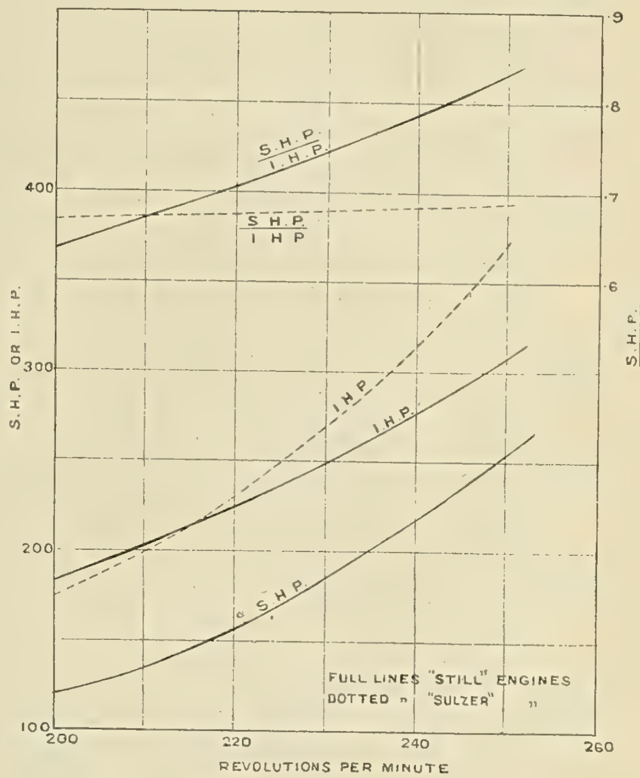


Fig. 5.—Horsepower Curves

A small boiler is part of the installation, from which the steam generated by burning oil in the boiler in the usual way is employed as the starting agent for the engine. The boiler also acts as a receiver for the steam derived from the waste heat of the exhaust gases of the internal combustion part of the engine. The feed water is circulated by a pump drawing from the bottom of the boiler and discharging through the tubes of a generator, which is heated by the exhaust gases of the engine passing round the tubes; from thence the water passes to the cylinder jackets of the engine, where it is used as the cooling agent, thus gaining more heat, and thereafter returns to the boiler in the form of steam and water. The steam thus generated is used in the steam end of the cylinder and adds to the power of the engine as a whole. The exhaust gases pass to the atmosphere on leaving the generator.

When the engine is running normally, i. e., under "waste heat" conditions, no fuel is burned in the boiler, the steam available being generated solely from the heat in the exhaust gases and from the heat transferred through the cylinder liner to the jacket water.

The engine may be run at a considerable overload by augmenting the supply of steam through burning fuel in the boiler.

Owing to the high temperature of the cylinder jacket cooling water (i. e., boiler water), the compression pressure in the cylinder necessary for the ignition of the fuel is considerably lower than is the case in ordinary Diesel engine practice.

The cycle of the steam portion of the engine is just as in ordinary steam practice, an air and circulating pump, condenser, boiler feed pump, etc., forming part of the installation.*

The Sulzer engines in question have cylinders approximately 8½ inches diameter by 13¾ inches stroke, four cylinders to each engine, and are of the two cycle type. The Still engines have also four cylinders per set, 7¼ inches diameter and 15 inches stroke, fitted with a boiler of the Yarrow type; they are of the opposed piston type and two cycle.

The Still engines were designed with a view to their powers of maneuvering being beyond question. It was suggested that a separate high pressure cylinder might be fitted, the other cylinders being the second unit of the ordinary compound engine. By this means some economy might have been effected, but this complication was decided against. It may be added, while it has nothing to do with the question of relative economy of the engines, that the Still engines were arranged to run astern under steam only. Owing to this, the boiler was larger than would be necessary in an engine arranged for astern working with oil also.

The Sulzer engines, on the other hand, were made to the patentee's design of 1913. Improvements have been made since then, and it is possible that some of these improvements may tend towards greater economy.

It will be observed that the Sulzer engine cylinder capacity is considerably larger than that of the Still engine, which has an effect on the varying relative consumptions at the different numbers of revolutions.

In the Still engine the maximum revolutions without overloading and without the use of oil in boiler were about 240.

A representative of each patentee was present at the trials of his own system and was satisfied that the trials had been carried out in an approved manner. The trials were continued until these representatives were unable to suggest any modifications where better results might be obtained.

The oil used on the trials was shale 0.85 specific gravity.

The maneuvering of both types of engines was quite satisfactory. From ahead to astern the time was about five seconds, and in this respect the Still engine had a slight advantage.

During the trials, as shown on Fig. 4, the Still engine worked entirely under waste heat conditions, i. e., no oil was burned in the boiler.

It had been suggested that, in the case of the Still engine, oil from the cylinders might find its way to the boiler and have a dangerous effect on it. With this possibility in view, the boiler was frequently examined during the trials with the Still engine, and also at their termination, and there was practically no oil deposit found. On the other hand, the feed water filters required frequent attention. The generators remained clean throughout the trials.

The Sulzer engines were entirely constructed by the firm of William Denny & Brothers, but in the manufacture of the Still engines, owing to pressure of work in their own establishment, the assistance and co-operation of Messrs. T. A. Savery & Company, Ltd., Birmingham, was arranged for.

In carrying out the trials the principal aim was to ascertain accurately the oil used in terms of the speed of the vessel, being the point of view most likely to appeal to the shipowner.

The following illustrations are shown: Fig. 1, Sulzer engine; indicator cards. Fig. 2, Still engine, oil and steam; indicator cards. Fig. 3, thermal efficiency (approximate). Fig. 4, oil consumption in terms of revolutions (or speed). Fig. 5, indicated horsepower and shaft horsepower in terms of revolutions.

The shaft horsepower was taken by torsionmeter. The facilities for fitting this gear were limited, and the results must be regarded as approximate.

The thermal efficiency also is only to be regarded as approximate, as the exact calorific value of the fuel oil was not available; it was assumed to be 19,000 British thermal units.

The total weight of the Sulzer installation is 25 tons, and of the Still installation, with its special accessories and boiler, 29 tons; but, as previously stated, the boiler was larger than would have been necessary if the engines had been designed to work astern under oil.

* As the experimental engines in question were started and maneuvered astern under steam, and as in this case the solid oil injection principle was adopted, no storage of compressed air nor compressor were necessary or were provided.

European Motorship Building

BY OUR SPECIAL LONDON CORRESPONDENT

NEARLY all the British shipbuilders who have recently decided to enter upon marine Diesel engine manufacture have acquired licenses from firms which have already gained a good deal of experience, and it is indeed very unusual at the present time for any concern to start oil engine manufacture from entirely original designs. One of the exceptions to this rule is the North British Diesel Engine Works, Ltd., which has established a large new factory on the Clyde solely for building engines for motorships, and the first sets which have been constructed ran their shop trials in September.

Confidence Shown in New Design of Diesel Engine

The results are being awaited with the greatest interest in shipbuilding and engineering circles in the United Kingdom, for, although none of these engines has yet been put into operation, one of the leading British shipping firms, The British India Steam Navigation Company, has such confidence in the design that it has ordered six large motors for installation in three 11,000-ton motor cargo and passenger vessels which are now being built on the Clyde. In addition, the Union Steamship Company, of New Zealand, has contracted for two further sets, while a similar engine is to be installed in an existing tank steamer and two small ships are to be equipped with twin screw plants of the same type but of lower power. This confidence in an entirely new design is a matter of considerable interest and appears to point to the fact that it is possible to start Diesel engine manufacture and make it a profitable undertaking without having to pass through a long period of costly experimental work.

The new engine is of the four cycle type, and the majority of the sets being built develop 2,300 indicated horsepower each in eight cylinders of 26 inches diameter with a stroke of 47 inches. As the motor runs at the low speed of 96 revolutions per minute, it is necessarily somewhat heavy and of considerable height. The construction is unusual in many respects, and an entirely new reversing system has been adopted. The engine is divided into two sets of four separate cylinders, each set being carried on an entablature, which is itself supported by steel bolts extending down to the bottom of the bedplate. There are also cast iron columns, but these are comparatively light and narrow, and take none of the load, while plates fixed between them enclose the whole of the engine, as forced lubrication is used throughout.

Novel Reversing System Adopted

The principle of the reversing system is to provide two side by side cams on the camshaft for the operation of each valve—exhaust, inlet, fuel and starting air—and to move the camshaft fore and aft on reversing. The main novelty lies in arranging for taking the rollers (attached to the short vertical push rods operating the valves) out of contact with the cams before the camshaft is shifted. This is effected by lowering the camshaft bodily by means of a rack and pinion operated from the normal type of reversing air engine. The usual method is to provide some device to lift the levers or rollers themselves, the camshaft remaining stationary, so that it will be seen that the ordinary arrangement is exactly reversed. Sea water is used for piston cooling, which is by no means general, as there is a tendency among European builders to employ fresh water for this purpose, and there are many other interesting points of which details will be given after the trial results have become available.

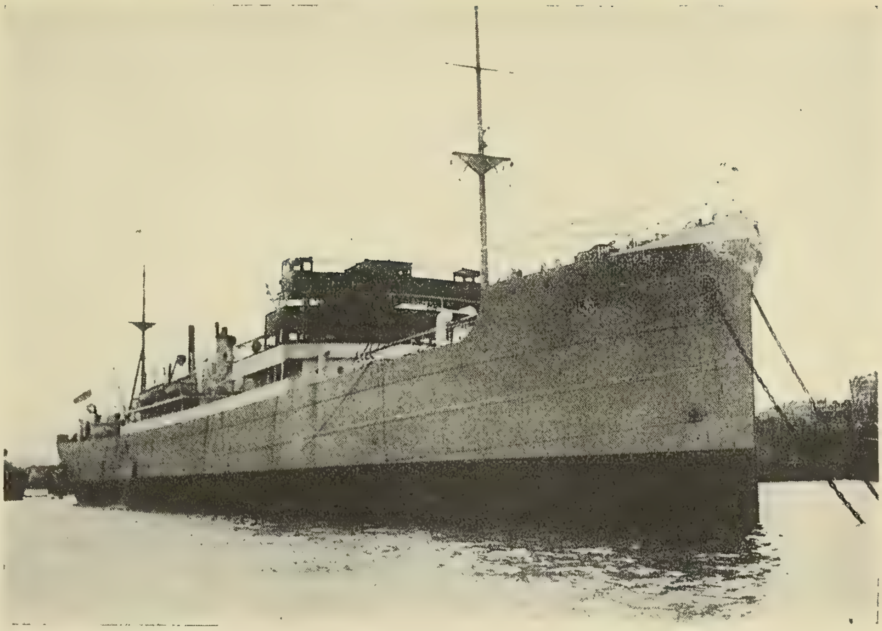


Fig. 2.—The New 9,400-Ton Motorship *Elmaren* Recently Completed by Götaverken at Gothenburg, Sweden, for the Transatlantic Steamship Company, Gothenburg

Motorship Building in Germany

It has already been mentioned that there are signs of awakening activity in oil engine building in Germany, and it is particularly interesting to learn that Blohm and Voss, of Hamburg, the builders of the double acting engined ship *Fritz* (now being run by the British Glen Line), are constructing double acting two cycle engines to the same design of much larger size. They are thus apparently satisfied that this is the right type, and it will be interesting to note whether any other European firms will follow suit. The A. E. G.-Hamburg-American Line combination, which established a works near Hamburg to build motorships equipped with opposed piston Diesel engines, has now given up this design and will manufacture the ordinary four cycle Burmeister and Wain type under license from the Danish firm. In view of these developments, it would not be entirely surprising to see Germany take a prominent place in motorship building construction within the course of the next few years.

Motorships of 18,000 Tons

One of the most important orders that has recently been placed for motorships is that which has just been settled in Copenhagen by the East Asiatic Company. This company has contracted for three cargo carrying motorships, the dimensions of which are not yet definitely settled. The ships will, however, carry approximately 18,000 tons of cargo at a speed of 11½ to 12 knots and will be built, like the majority of the other motor vessels for the same firm, by Burmeister and Wain at Copenhagen. The total machinery power will be in the neighborhood of 8,000 or 9,000 horsepower, and either a triple or quadruple screw arrangement will be adopted. It is probable that the former will be chosen and that three 8-cylinder engines of about 3,000 horsepower will be installed in this ship, similar in general type and construction to the two engines of the same power being fitted in the standard 14,000-

Fig. 1.—The 12,000-Ton Bibby Motorship *Dorsetshire* Fitted With 4,500 Horsepower Machinery, Ready for Her Maiden Voyage

ton motorships which are now being built for the Glen Line.

The East Asiatic Company has progressively increased the size of its motorships, starting with the 8,000-ton *Selandia* in 1912, while the last ship completed was the *Afrika*, of 14,000 tons, equipped with two 2,250-horsepower motors. One of the main reasons for the gradual increase in size is that owners of motorships consider them to be especially suited for long voyages and for carrying a large amount of cargo at a reasonably high speed. The internal combustion engine ship shows to special advantage in this direction, owing to its economy in fuel, for the 18,000-ton ship mentioned will consume only about 27 tons of oil per day, which is no more than is required for an oil burning steamer carrying 10,000 tons at 10½ or 11 knots.

Although they have hitherto not interested themselves greatly in motorship construction, Messrs. Armstrong, Whitworth and Company have now decided to enter energetically into this new field and are building their first motor vessel for Spanish owners. She is a 6,500-ton craft, 390 feet in length, with a designed speed of 11½ knots. The machinery installation, which will be built by Armstrongs in conjunction with Sulzers under license from the Swiss firm, comprises a couple of four cylinder, 1,250 brake horsepower, two cycle motors of the ordinary Sulzer design, running at 100 revolutions per minute and having cylinders 600 millimeters diameter and 930 millimeters stroke. It is probable that the Armstrong's decision in this connection has been brought about by the immense activities which are now being shown by two of the largest shipbuilding concerns in the United Kingdom, namely, Vickers and Harland & Wolff.

Relative Power and Space Occupied By Various Types of Diesel Engines*

BY ENGINEER-COMMANDER C. J. HAWKES, R. N. (RET.)

COMPARISONS have frequently been made between Diesel engines of various types in regard to power and space occupied, but in many cases such comparisons have either been based on assumptions which could not be wholly accepted or certain assumptions have been taken no doubt with the object of emphasizing the advantages of a particular engine. A short time ago the author had occasion to look into this question with the object of ascertaining the approximate brake horsepower which could be developed by high duty Diesel engines of the four stroke single acting, two stroke single acting, and two stroke double acting types, designed for the same overall length and height. The engines considered were based on laboratory designs. It is not possible in this paper to give in detail the whole of the assumptions made, but the principal points assumed were:

(1) Air injection in all cases.

(2) The compressor and scavenge pumps driven from the main engines.

(3) Separate guides in the case of the two stroke engines and trunk pistons only in the case of the four stroke engines.

Taking the power developed by the eight cylinder four stroke engine as the unit, the comparative figures obtained are shown in Table I:

* From a paper on "Some Experimental Work in Connection with Diesel Engines," read at the summer meetings of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

TABLE I

Type of Engine	Number of Cylinders	Comparative Figure for Brake Horsepower (8-Cylinder, 4-Stroke Engine Taken as Unity)
Four-stroke, single acting.....	8	1
Four-stroke, single acting.....	6	1.22
Two-stroke, single acting.....	6	1.44
Two-stroke, single acting.....	8	1.38
Two-stroke, double acting.....	6	1.9

With the assumptions taken it will be seen that it is advantageous to keep down the number of cylinders in an engine; also, the increase of power resulting from the adoption of the two stroke single acting engine is not very marked. There is a distinct advantage in favor of the two stroke double acting engine, but it would be more complicated and its use could only be justified for higher powers than those at present contemplated.

Although the comparative figures arrived at are correct for the assumptions taken, other points, in addition to space occupied, have to be considered when deciding on the type of engine to be used for powers larger than those at present in use or under construction. The advantages and disadvantages of the various types are well known and need not be discussed in this instance. For powers of the order of 2,000 brake horsepower per engine for high speed naval work there would be no great difference in the widths of the three types of engines, but as the power increased it is probable that the width of the four stroke engine would be slightly greater than the widths of the two stroke engines—at least so far as the six cylinder engine is concerned. This would necessitate a wider engine room in order to accommodate pistons and covers when dismantling.

It has been assumed in these comparisons that the four-stroke engines are not fitted with separate crossheads, as in the case of the two stroke engines. If separate crossheads were fitted, it would be necessary to reduce the stroke of the engine for a given headroom, so that either the piston speed would have to be reduced, or, if the piston speed were maintained, the inertia forces would be increased. This, in addition to the size of the cylinder, etc., would probably limit the use of four cycle engines for comparatively high powers.

Other assumptions in regard to the method of driving the scavenge pumps, number of cylinders per engine, etc., could be taken in order to arrive at comparative figures for brake horsepowers solely from the point of view of space occupied, but it is considered that the cases worked out give a good idea of what may be generally expected. It is clear from the results given that, compared with the four stroke engine, the increase in power obtained by the adoption of the two stroke single acting or two stroke double acting engine is not so great as is frequently stated.

Although, from the point of view of actual performance under seagoing conditions, the four stroke engine has proved more reliable than the two stroke engine for submarine propulsion, the possibilities of the latter cannot be overlooked. The four stroke engine was the first in the field and has received more attention, but the two stroke engine is the natural line of development, and it may prove of considerable value should greater powers be required in the future than those at present contemplated.

A low fuel consumption is, of course, desirable, but other factors, e. g., weight and space, are also of great importance where naval engines are concerned. If, therefore, the two stroke engine is developed so that there are no doubts as to its reliability, it is considered that it will prove a serious competitor to the four stroke engine, even for moderate powers, for it can be made a more simple engine so far as the vital parts are concerned.

Cargo Motorships vs. Steamships—II

Fixed Annual Expenses and Service Expenses—Cost of Cargo Transportation, Net Earnings and Investment Returns

BY CHARLES E. LUCKE*

ALL earnings are derived from cargo handled and are to be estimated from the cargo capacities per Table 7 by applying an assumed freight rate. Freight rates are necessarily variable, so estimates of earnings must be also variable, especially as rates on return cargoes may be different than for outbound or no return cargoes obtainable. Figures are available on rates, ranging from $.75 to $3.50 per 1,000 ton-miles and showing a difference of 50 percent between outbound and return rates. As world trade conditions change, so must these rates change, so any estimate made may be entirely wrong shortly afterward.

For the purpose of indicating form of procedure, a rate of $3.50 per 1,000 ton-mile will be applied to the New York to Liverpool route, or 3.220 × 3.50 = $11 in round numbers per ton one way but applying to both directions. For the New York to Buenos Aires route $2.50 per 1,000 ton-miles, or 5.870 × 2.50 = $15 per ton, and New York to South Africa $3 per 1,000 ton-miles, or $3 × 8.000 = $24 per ton. The earnings are calculated on deadweight cargo capacity in Table 7 using these freight rates. A similar calculation can be made on the basis of bulk or measurement cargo, but this is omitted to avoid confusion due to two sets of figures.

TABLE 7.—GROSS EARNINGS ON DEADWEIGHT CARGO

		Steamship		Motorship	
Voyage	Item	Per Voyage	Per Year	Per Voyage	Per Year
New York to Liverpool and return; rate, $11.00 per ton; 5.3 voyages per year	Cargo tons...	17,680	93,704	19,030	100,859
	Earnings	$194,480	$1,030,744	$209,330	$1,109,449
New York to Buenos Aires and return; rate, $15.00 per ton; 4.1 voyages per year	Cargo tons...	16,120	66,092	18,450	75,645
	Earnings	$241,800	$991,380	$276,750	$1,134,675
New York to South Africa and return; rate, $24.00 per ton; 3.4 voyages per year	Cargo tons...	14,890	50,666	18,030	61,302
	Earnings	$357,360	$1,215,984	$432,720	$1,471,248

Expenses

Expenses are made up of items that may be classified as fixed charges and operating charges, but a better division is that in which all expenses of annual nature, independent of the cargo handled or number of voyages, are grouped together as *fixed annual expenses,* and all other items combined in another group as *service expenses.*

Fixed annual expenses include interest, depreciation (including obsolescence), maintenance, loss and damage, crew wages and subsistence, water and stores. *Service expenses* include fuel, cargo handling, insurance and port charges.

Interest, Depreciation and Obsolescence

Interest, depreciation and obsolescence can be treated as one item—the investment charges fixed by a definite annual percent of the first cost of the ship. Such a motorship as is here considered is valued at $1,950,000 and the steamship at $1,800,000. Values for the rate to be applied to the investment differ widely, some figures being as high as 10 percent for depreciation and obsolescence and 6 percent interest, but usually the high figures are based upon an assumption of short life of machinery, or on a desire to write off on the books the value of the ship as soon as possible as a matter of accounting policy.

Basing a figure on the estimated life of the ship taken at twenty years and carrying the account for the full time, it is possible to charge interest at 6 percent on the decreasing book value and to depreciate or obsolesce the investment at 2 percent for the first year; thus, keeping a constant total of 8 percent per year, write off the account in twenty years. On this basis, the annual investment charge is .08 × $1,800,000 = $144,000 for the steamship and .08 × $1,950,000 = $156,000 for the motorship, leaving a difference of $12,000 against the motorship.

Maintenance

Maintenance includes both material and labor required for the upkeep of the ship and machinery over what the regular crew can accomplish. Considerable information is available on the maintenance cost for steam vessels with Scotch boilers and reciprocating engines, indicating that a fair figure for a 10,000-ton ship would be close to $10,000 per year for machinery, a considerable part being chargeable to boilers, and at pre-war rates. Simliar information collected from motorship owners indicates that a correspondingly fair figure for Diesel machinery of modern design would be about $8,000 per year. Very little information is available for geared turbine steamers, but it seems fair to assume that the upkeep cost would be less than for reciprocating engines. In view of the fact that most of the expense is due to boilers, it seems that the fair proportionate figure would be $8,000 for the geared turbine against the $10,000 for reciprocating engine.

These figures indicate that the maintenance of the machinery of the motorship and geared turbine steamship with Scotch boilers is about the same, and about $8,000 per year at pre-war rates, or $20,000 at present prices of supplies, wages of shipyard and machinery, labor and present output per man. To this this must be added maintenance charges for the ship, fittings and deck gear, which, it is assumed, will bring the total to $50,000 per year for both ships, or $5 per deadweight ton per year.

Crew wages and subsistence charges are based on assumed complement and rate of wages, with allowances of $1 per day per man for subsistence. The crew is divided into three groups: (a) deck, (b) steward, these two being the same for steamship and motorship, and (c) engine, in which there are some differences. A careful study of the situation has led to the adoption of Table 8 for the engine crew for the 10,000-ton vessels under construction.

These men make up three watches and a day working party, each of which has the following complement:

Group	Steamship	Motorship
Watch	1 senior engineer in engine room 1 oiler in engine room 1 wiper in engine room 1 water tender in boiler room 1 fireman in boiler room	1 senior engineer 1 junior engineer 1 oiler
Day Working Party	1 deck engineer	1 deck engineer 1 junior engineer 1 oiler

* Professor of mechanical engineering, Columbia University, New York, and consulting engineer, Worthington Pump and Machinery Corporation, New York.

TABLE 8.—ENGINE CREW WAGES AND SUBSISTENCE

Position or Title	Wages per Man	Steamship Number	Steamship Wages per Month	Motorship Number	Motorship Wages per Month
Chief engineer	$346.25	1	$346.25	1	$346.25
First	235.00	1	235.00	1	235.00
Second	206.00	1	206.00	1	206.00
Third	182.50	1	182.50	1	182.50
Deck	182.50	1	182.50	1	182.50
Junior	150.00	..	....	4	600.00
Oilers	95.00	3	285.00	4	380.00
Wipers	90.00	3	270.00	..	....
Water tenders	95.00	3	285.00	..	....
Firemen	90.00	3	270.00	..	....
Total	$1,772.25	17	$2,262.25	13	$2,132.25

The steamship monthly wages for engine crew of $2,262.25 is equivalent to 12 × 2,262.25 = $27,147 per year, to which must be added subsistence for 17 men at $1 per day, or 17 × 365 = $6,205, making the total $27,147 + $6,205 = $33,352 per year.

For the motorship the year wages are 12 × 2,132.25 = $25,587, to which add subsistence 13 × 365 = $4,745, making the total $25,587 + $4,745 = $30,332 per year.

Not only is there a difference in crew cost in favor of the motorship, but the most troublesome class of labor is eliminated—the coal passers and firemen—and the smaller motorship crew of higher class men is very much easier for the chief engineer to manage.

To provide suitable men for this new service, Worthington is prepared to train men with suitable experience in its shops where the engines are tested complete before installation in ships.

Deck and steward complements are not analyzed in detail here, but are estimated at 16 men in the deck and 10 men in the stewards' departments, a total of 26 men. These men will receive in wages $33,688, to which add subsistence of 26 × 365 = $9,490, making the total $43,178. This, when added to the total for the engine crew, makes the grand total of yearly crew expense $33,352 + $43,178 = $76,530 for the steamship, and $30,332 + $43,178 = $73,512 for the motorship.

Stores

Stores, exclusive of those covered by subsistence, are estimated on the quantity of one ton per day used in analyzing deadweight, and are priced at the average figure of $65 per ton for all three departments, engine, deck and steward, and the same for both types of ships. This adds to the annual expense a total of 365 × 65 = $23,725.

Loss and Damage

Loss and damage estimates seem to be pure guesses, and figures have been called to our attention ranging from $5 to nearly $20 per day for ships of 10,000 tons, but varying somewhat with freight rates, routes, port conditions and amount of cargo. It is, at any rate, quite the same for the two types of ships, so that any reasonable estimate can be regarded as proper within the scope of such a comparison as this, and it is, furthermore, quite a small item. As time is certainly a factor, the rate assumed is based on days and the figure taken as $10 per day for both ships. On this basis the item becomes an annual charge of $3,650 per year against each ship.

Water Expense

Water expense based on the crew consumption of about 20 gallons per day per man and about 2 percent of the boiler evaporation as make-up for the steamer would be a service charge, were it not for the fact that the steamship port water losses are substantially the same as at sea. It may, therefore, be assumed that both ships will use water continuously at the rates of Table 3, which are 13 tons per day for the steamship and 3 tons per day for the motorship. The rate to be charged for the water is based on that for water purchased at New York City—$1 per 1,000 cubic feet, which in round numbers is 3 cents per long ton. This makes the daily costs $4 for the steamer and $1 for the motorship.

Accordingly, the annual water charge for the steamship is 4 × 365 = $1,460, and for the motorship $365.

Fixed annual expenses in the aggregate are summarized in Table 9:

TABLE 9.—FIXED ANNUAL EXPENSE

Item	Steamship	Motorship
Investment charge	$144,000	$156,000
Maintenance	50,000	50,000
Crew wages and subsistence	76,530	73,512
Stores	23,725	23,725
Loss and damage	3,650	3,650
Water	1,460	365
Total	$299,365	$307,252

Service Expenses

Service expenses all vary with the number and length of voyages, and include the items of fuel, cargo, handling, insurance and port charges. Each expense item can be estimated only on an assumed price or rate, and these are subject to natural trade fluctuations, so that any overall result must be checked before using it as a basis of commercial conclusion by applying new prices and rates prevailing at the time and place under consideration.

Fuel Expense

Fuel expense is partly a matter of fuel consumption determined in Table 5, but quite as much a matter of fuel price. Fuel oil prices are very uncertain, differing not only in different ports for the same grade of oil and with appreciable differences appropriate to grades (the lighter being higher in price), but at any one place prices fluctuate from day to day. About the only stable element of oil prices is the general upward trend that has prevailed for several years and which, according to present indications, will continue at least for the near future.

The range of variation in prices in different world ports for one set of figures for 1919 was from $.80 per barrel minimum at Gulfport to $10 per barrel maximum at a China port, and the bulk of the figures are between $1 and $4 per barrel. As it is necessary to adopt a price to complete the estimate of expenses of operation, a round figure of $3 per barrel is selected as a fair value for the present and immediate future for 16-degree Baumé oil for the steamship boilers and $3.50 for 22-degree Baumé oil for the motorship engines, retaining the usual excess over the former, which is about 15 percent. These prices correspond to $3 × 6.67 = $20.01 per ton for 16-degree Baumé oil, and $3.50 × 6.95 = $24.32 per ton for 22-degree Baumé oil. On these figures the fuel expense per trip and per year is worked out as in Table 10 for three typical voyages:

TABLE 10.—FUEL OIL EXPENSE

Voyage		Steamship, Oil at $3.00 Barrel 16 Degrees Baumé: Trip	Steamship: Year	Motorship, Oil at $3.50 Barrel 22 Degrees Baumé: Trip	Motorship: Year
New York to Liverpool and return, 6,439 miles; 5.3 voyages per year	Oil required, tons	1,051	5,570	342	1,813
	Fuel expense	$21,030	$111,459	$8,317	$44,080
New York to Buenos Aires and return, 11,740 miles; 4.1 voyages per year	Oil required, tons	1,741	7,138	602	2,468
	Fuel expense	$34,837	$142,831	$14,641	$60,027
New York to South Africa and return, 16,000 miles; 3.4 voyages per year	Oil required, tons	2,298	7,813	810	2,754
	Fuel expense	$45,983	$156,342	$19,699	$66,977

It will be noted that the very much lower fuel consumption of the motorship is responsible for a big margin of difference in fuel expense, even if the more expensive grade of fuel is selected as a matter of convenience. Thus, for the shortest of the three voyages, that to Liverpool, there is a saving of $67,500 per year by the motorship against the steamship expense of $111,500; for the medium voyage, that to Buenos Aires, the motorship saves over $83,000 per year against the steamship expense of over $143,000 per year. These substantial savings overbalance all the excesses of fixed annual charges by very considerable margins and are the main factors in the general overall commercially economic superiority of the motorship. Of course, the lower fuel prices will reduce this margin, but will not eliminate it until fuel prices are lower than they will ever be, except possibly at the producing points, or materially less than $1 per barrel.

Cargo Handling

Cargo handling expense is to be based on an estimated rate per ton handled, each ton being handled twice—once in loading and again discharging at another port, so the rate must be the average for all ports. While the rate will be determined in specific cases by handling facilities, labor wage rates and efficiency of the labor, it is sufficient for present purposes to take a flat fixed rate of $2 per ton, as the rate will be the same for both ships and will not materially affect the comparison of the types. On this basis the figures of Table 11 were computed from the figures on total cargo from Table 6:

TABLE 11.—CARGO (DEADWEIGHT) LOADING AND DISCHARGING EXPENSE

		Steamship		Motorship	
Voyage	Item	Voyage	Year	Voyage	Year
New York to Liverpool	Cargo handled, tons	17,680	93,704	19,030	100,859
	Expense	$35,360	$187,408	$38,060	$201,718
New York to Buenos Aires	Cargo handled, tons	16,120	66,092	18,450	75,645
	Expense	$32,240	$132,184	$36,900	$151,290
New York to South Africa	Cargo handled, tons	14,990	50,966	18,030	61,302
	Expense	$29,980	$101,932	$36,060	$122,604

Insurance

Insurance is based on ship valuation, and the rates per voyage depend on the voyage, which, of course, are variable, depending partly on hazard and partly on commercial conditions. Omitting such special risks as war and piracy, the rates used in Table 12 are reasonable possibilities and about in correct relative proportion:

TABLE 12.—INSURANCE EXPENSE

		Steamship $1,800,000		Motorship $1,950,000	
Voyages	Item	Trip	Year	Trip	Year
New York to Liverpool and return; rate, ½ percent; 5.3 voyages per year; 67 days	Insurance....	$9,000	$47,700	$9,750	$51,675
New York to Buenos Aires and return; rate, 1 percent; 4.1 voyages per year; 87 days	Insurance....	$18,000	$73,800	$19,500	$79,950
New York to South Africa and return; rate, 1½ percent; 3.4 voyages per year; 104 days	Insurance....	$27,000	$91,800	$29,250	$99,500

Port charges, including wharfage and pilotage, are specific items for each port, depending on local conditions there, and are, of course, the same for both types of ship. The figures of Table 13 are believed to be fair estimates:

TABLE 13.—PORT CHARGES, WHARFAGE AND PILOTAGE EXPENSE

	Steamship		Motorship	
Voyage	Voyage	Year	Voyage	Year
New York to Liverpool, 5.3 trips per year	$8,000	$42,400	$8,000	$42,400
New York to Buenos Aires, 4.1 trips per year..................	6,000	24,600	6,000	24,600
New York to South Africa, 3.4 trips per year..................	9,000	30,600	9,000	30,600

Service expenses are obtained in Table 14 by adding all the separate items for each voyage:

TABLE 14.—SERVICE EXPENSE

		Steamship		Motorship	
Voyage	Item	Voyage	Year	Voyage	Year
New York to Liverpool and return	Fuel	$21,030	$111,459	$ 8,317	$ 44,080
	Cargo handling...	35,360	187,408	38,060	201,718
	Insurance	9,000	47,700	9,750	51,675
	Port charges.....	8,000	42,400	8,000	42,400
	Total	$73,390	$388,967	$64,127	$339,873
New York to Buenos Aires and return	Fuel	$34,837	$142,831	$14,641	$ 60,027
	Cargo handling...	32,240	132,184	36,900	151,290
	Insurance	18,000	73,800	19,500	79,950
	Port charges.....	6,000	24,600	6,000	24,600
	Total	$91,077	$373,415	$77,041	$315,867
New York to South Africa and return	Fuel	$45,983	$156,342	$19,699	$ 66,977
	Cargo handling...	29,780	101,332	36,060	122,604
	Insurance	27,000	91,800	29,250	99,500
	Port charges.....	9,000	30,600	9,000	30,600
	Total	$111,763	$380,074	$94,009	$319,681

Total expense of all kinds is summarized in Table 15 by adding together the totals of fixed annual expense, Table 9, and those of service expense, Table 14:

TABLE 15.—TOTAL EXPENSE

		Steamship		Motorship	
Voyage	Item	Voyage	Year	Voyage	Year
New York to Liverpool and return: 5.3 voyages per year	Fixed annual....	$56,484	$299,365	$57,972	$307,252
	Service	73,390	388,967	64,127	339,873
	Total	$129,874	$688,332	$122,099	$647,125
New York to Buenos Aires and return; 4.1 voyages per year	Fixed annual....	$73,017	$299,365	$74,939	$307,252
	Service	91,077	373,415	77,041	315,867
	Total	$164,083	$672,780	$151,980	$623,119
New York to South Africa and return; 3.4 voyages per year	Fixed annual....	$ 88,048	$299,365	$90,368	$307,252
	Service	111,763	380,074	94,009	319,681
	Total	$199,811	$679,439	$184,377	$626,933

4. Cost of Cargo Transportation, Net Earnings and Investment Returns

By bringing together the items of cargo handled in Table 6 and the total expenses incurred in Table 15, the transportation costs can be determined, and this is done in Table 16:

TABLE 16.—COST OF TRANSPORTATION OF CARGO (DEADWEIGHT)

		Steamship		Motorship	
Voyage	Item	Voyage	Year	Voyage	Year
New York to Liverpool and return, 6,439 miles	Cargo, tons.........	17,680	93,704	19,030	100,859
	Cargo 1,000 ton-miles				
	Total expense.......	$129,874	$688,332	$122,099	$647,125
	Cost per ton......	$7.34		$6.42	
	Cost per 1,000 ton-mile	1.14		1.00	
New York to Buenos Aires and return, 11,740 miles	Cargo, tons.........	16,120	66,092	18,450	75,645
	Cargo 1,000 ton-miles				
	Total expense.......	$164,083	$672,780	$151,980	$623,119
	Cost per ton......	$10.17		$8.23	
	Cost per 1,000 ton-mile	0.87		0.70	
New York to South Africa, 16,000 miles	Cargo, tons.........	14,890	50,666	18,030	61,302
	Cargo 1,000 ton-miles				
	Total expense.......	$199,811	$679,439	$184,377	$626,993
	Cost per ton......	$13.42		$10.23	
	Cost per 1,000 ton-mile	0.84		0.64	

These costs per ton per voyage when compared with the freight rates of $11 per ton to Liverpool, $15 per ton to Buenos Aires and $24 per ton to South Africa indicate a good margin of profit even if the rates were considerably reduced. In all cases, also, the motorship costs per ton-mile are appreciably lower by about 14 percent, 20 percent and 22 percent in the three cases, which is an increasing percent for the longer trip and smaller costs.

Net earnings and investment returns are summarized in Table 17, the figures for gross earnings being transferred from Table 7, those for total expense from Table 15, and the difference in net earnings per year computed in terms of percent return on the investment.

TABLE 17.—NET EARNINGS AND INVESTMENT RETURNS

Voyage	Item	Steamship $1,800,000 Valuation Voyage	Steamship $1,800,000 Valuation Year	Motorship $1,950,000 Valuation Voyage	Motorship $1,950,000 Valuation Year
New York to Liverpool and return; 5.3 voyages per year	Gross earnings	$194,480	$1,030,744	$209,330	$1,109,449
	Total expense	129,874	688,332	122,099	647,125
	Net earnings	$64,606	$342,412	$87,231	$462,324
	Investment returns, percent per year		19.0		23.8
New York to Buenos Aires and return; 4.1 voyages per year	Gross earnings	$241,800	$991,380	$276,750	$1,134,675
	Total expense	164,083	672,780	151,980	623,114
	Net earnings	$77,717	$318,600	$124,770	$511,561
	Investment returns, percent per year		17.70		26.25
New York to South Africa and return; 3.5 voyages per year	Gross earnings	$357,860	$1,215,984	$432,720	$1,471,248
	Total expense	199,811	679,439	184,377	626,993
	Net earnings	$157,549	$536,545	$248,343	$844,255
	Investment returns, percent per year		29.80		43.32

These figures of net return on investment are all favorable to the motorship, and more so as the length of the voyage is greater. Comparing the net returns directly, the motorship yield is for the three voyages—Liverpool, Buenos Aires and South Africa—1.26, 1.48 and 1.45 times those for the steamship. These differences demonstrate clearly the necessity of such calculations as these to determine the most profitable routes for motorships as compared with steamships.

Another basis of comparison of some merit is the excess of net earnings of the motorship on the excess investment. This investment excess is $1,950,000 — $1,800,000 = $150,000. The excess of net yearly earnings of the motorship for the three typical voyages in order is $119,912, $192,961 and $307,710. These net yearly returns represent percent returns on the extra motorship investment of $150,000 of 82 percent, 129 percent and 205 percent respectively, showing a uniformly increased return on the investment excess on the whole amount for the three voyages studied and increasing with length of voyage. Attention is again called to the case of bulk cargo, in which results are also favorable to the motorship, but omitted for the sake of greater clearness.

These comparative calculations for the operations of steamships and motorships are presented primarily to show that the motorship has decided advantages over the steamship on a purely commercial profit earning basis, when care is exercised in selecting suitable service conditions and a proper trade route. The selection of proper conditions and the decision as to the commercial value of a motorship over a steamer cannot be made in a haphazard manner, and general overall figures are apt to be misleading, to say the least. There is only one way known to get at the facts, and that is the preparation of a carefully itemized statement, with each separate factor as accurately determined as possible for the conditions to be met, and the object of the bulletin is to assist those interested by presenting these forms and tables.

An invitation is extended to all concerned to send in further data on any or all of these items that will contribute to improvement of future estimates, both as to volume of data for all sorts of conditions and the accuracy of the figures as derived from actual experience in ship operation.

APPENDIX

TABLE 18.—FUEL OIL SUPPLY STATIONS—PARTIAL LIST

1. Agna Santa Railroad Company.
   Peru—Callao.
2. American Petroleum Company.
   Holland—Amsterdam and Rotterdam.
3. Anglo-American Oil Company, Ltd.
   United Kingdom—Avonmouth, Barrow, Belfast, Birkenhead, Brixham, Dublin, Glasgow, Grangemouth, Hull, Liverpool, Manchester, Newcastle, Plymouth, Purfleet, Southampton, Sunderland.
   Africa—Cape Town, Bizerta.
   Argentine—Campana.
   Brazil—Rio Janeiro.
   Chile—Antofagasta, Iquique, Pisagua, Taltal, Tocopilla, Valparaiso.
   Peru—Callao, Payta, Talara.
   Uruguay—Montevideo.
   Canada—Halifax, Montreal, Prince Rupert, Vancouver.
   Denmark—Aalborg, Copenhagen, Odense.
   Italy—Genoa, Monopoli, Savona, Venice.
   Mexico—Tampico.
   Norway—Bergen, Christiania, Portici, Vallo.
   Panama Canal.
   Porto Rico—Ponce, San Juan.
   Sweden—Gothenburg, Stockholm.
   United States—Baltimore, Baton Rouge, Bayonne, N. J., Beaumont, New Orleans, New York, Norfolk, Va., Philadelphia, Port Arthur, Portland, Ore., Sabine, San Francisco, San Pedro, Seattle, Wash.
   Cuba—Cienfuegos, Havana, Matanzas.
   Dutch W. I.—Curacao.
   China—Hong Kong, Shanghai.
   Japan—Yokohama.
   Hawaii—Honolulu.
4. Anglo-Mexican Oil Corporation.
   England—Barton, Grimsby, Hull, Liverpool, London, Manchester, Thames Haven.
   Mexico—Puetro Mexico, Salina Cruz, Tampico, Tuxpan, Vera Cruz.
   Brazil—Bahia, Ponta de Coja, Nictheroy, Rio de Janeiro, Santos.
   Argentine—Buenos Aires.
   Uruguay—Montevideo.
   Virgin Islands—St. Thomas.
5. Anglo-Persian Oil Company.
   India—Bombay.
6. Anglo-Saxon Petroleum Company.
   Portugal—Lisbon.
7. Asiatic Petroleum Company.
   Portugal—Lisbon.
   Egypt—Alexandria, Port Said, Suez.
   Borneo—Balik Papan, Tarakan.
   Siam—Bangkok.
   Java—Batavia, Surabaya.
   India—Bombay, Calcutta, Cochin, Conconada, Tuticorin, Karachi, Madras, Rangoon.
   South Africa—Cape Town.
   Ceylon—Colombo.
   China—Hong Kong, Shanghai, Singapore.
   Canary Islands—Las Palmas.
   Japan—Nagasaki, Saitakaki.
   Sumatra—Palembang, Sabang.
   Australia—Sydney.
8. Associated Oil Company.
   Hawaii—Honolulu.
   United States—Portland, Ore., San Francisco, Cal.
9. British Imperial Oil Company.
   Australia—Adelaide, Melbourne, Sydney.
   South Africa—Cape Town.
   Holland—Rotterdam.
   Egypt—Suez.
10. British Petroleum Company.
    England—Avonmouth.
11. Belcher Asphalt Paving Company.
    United States—Miami, Fla.
12. Cairns, R.
    Scotland—Leith.
13. Caloric Company.
    Brazil—Hahia, Rio de Janeiro.
14. Curacao Petroleum Company.
    West Indies—Curacao.

15. Det. Panske Petroleum Akt.
Norway—Bergen, Christiania.
Denmark—Copenhagen.
Sweden—Stockholm, Gothenburg.
16. Compania Mexican de Petrolio.
Mexico—Salina Cruz, Vera Cruz.
17. Duncan Fox & Company.
Chile—Antofagasta, Valparaiso.
18. Ferro Carril de Junin.
Chile—Junin.
19. Grace, W. R., & Company.
Peru—Callao.
Salvador—La Union.
20. General Petroleum Company.
United States—San Pedro, Cal.
21. Gulf Refining Company.
United States—Port Arthur, Texas.
22. Hoden Oil Company.
Japan—Niigata.
23. Imperial Oil Company, Ltd.
Canada—Halifax, N. S., Montreal, Prince Rupert, B. C., Vancouver, B. C., Victoria, B. C.
24. International Petroleum Corporation.
Chile—Antofagasta, Iquique, Pisagua, Taltal, Tocopilka, Valparaiso.
Peru—Callao, Paita, Talara.
25. Importazione Oil.
Italy—Palermo, Sicily.
26. Johnson, A., & Company.
Sweden—Gothenburg.
27. International Railways of Central America.
Guatemala—San Jose.
28. Lykes Brothers.
Cuba—Havana.
29. Magnolia Petroleum Company.
United States—Galveston, Tex.
30. Marnzen Mineral Oil Company.
Japan—Kobe.
31. Mexican Petroleum Corporation.
Brazil—Bahia, Tuxpan, Rio de Janeiro.
United States—Jacksonville, Fla.; Portland, Me.; Providence, R. I.; Tampa, Fla.
32. Mead, King, Robinson & Company, Ltd.
England—Barton, Liverpool.
33. Mitchell, Cotts & Company.
South Africa—Cape Town.
34. Mitsubishi Company.
Japan—Kobe.
35. Panama Railroad Company.
United States—Balboa, Canal Zone.
36. Pan-American Petroleum and Transportation Company.
United States—Boston, Mass.; Cristobal, Canal Zone.
37. Rising Sun Company.
Japan—Aomori.
38. Royal Dutch Shell Company.
Holland—Amsterdam, Rotterdam.
West Indies—Curacao.
China—Hong Kong.
39. Salaverry Agencies Company.
Peru—Salaverry.
40. Shell Oil Company of California.
United States—San Francisco, Cal.; San Pedro, Cal.
41. Sinclair Oil Company.
Cuba—Havana, Matanzas.
42. Societe pour L'Importation des Huiles de Graissage.
Belgium—Antwerp.
43. Societe Italie Am. Petroleum.
Tunis, Africa—Bizerta.
Italy—Genoa, Monopoli, Portici, Venice.
44. Societe des Petroles Au Congo.
Africa—Ango Ango, Boma, Belgian Congo.
45. Standard Oil Company.
United States—Aberdeen, Wash.; Baltimore, Md.; Baton Rouge, La.; Key West, Fla.; Portland, Ore.; San Diego, Cal.; San Francisco, Cal.; San Pedro, Cal.; Seattle, Wash.; Tacoma, Wash.; Tampa, Fla.
Egypt—Alexandria.
India—Bombay, Calcutta, Cochin.
Italy—Genoa.
Hawaii—Honolulu.
Alaska—Ketchikan.
Japan—Nagasaki.
Brazil—Rio de Janeiro.
Greece—Salonica.
Turkey—Smyrna.
Java—Somalaya.
Mexico, Tuxpam.
46. Standard Oil Company of Louisiana.
United States—New Orleans, La.
47. Standard Oil Company of New Jersey.
United States—New York City, Norfolk, Va.
48. Texas Oil Company.
United States—Providence, R. I.; New York City, Philadelphia, Baltimore, Md.; Norfolk, Va.; Charleston, S. C.; Savannah, Ga.; Jacksonville, Fla.; Key West, Tampa, New Orleans, Gulfport, Miss.; Port Arthur, Tex.; Galveston, Port Aransas, Tex.; Colon, C. Z.
Porto Rico—Ponce.
49. Trinidad Leaseholds, Ltd.
Trinidad—Port of Spain.
50. Union Oil Company.
Canada—Vancouver, B. C.
Hawaii—Honolulu.
Chile—Valparaiso, Iquique, Taltal.
United States—Portland, Ore.; Port San Luis, Cal.; San Diego, Cal.; San Francisco, Cal.; San Pedro, Cal.; Seattle, Wash.
51. United British Refineries.
Trinidad—Port of Spain.
52. Vestlandske Petr. Komaui.
Norway—Bergen, Christiania, Stavanger.
53—Vacuum Oil Company.
Australia—Melbourne.
Egypt—Port Said.
54. West India Oil Company.
Argentina—Bahia, Blanca, Buenos Aires, Campana.
Peru—Callao, Paita, Talara.
West Indies—Curacao.
Uruguay—Montevideo.
Chile—Pisaga, Valparaiso.
Porto Rico—Ponce, San Juan.
Bermuda—St. George.
55. White, J. G., & Company.
Nicaragua—Corinto.
Cuba—Havana, Matanzas.
56. Williams & Balfour & Company.
Chile—Antofagasta, Valparaiso.

Measuring Liquids in Ships' Tanks

THE necessity of having a constant check on the depth of liquids in ships' tanks so that the vessel may be kept in proper trim at all times is too well known to need comment. Methods for measuring liquids vary, however, and, although there are few successful devices in operation at the present time, the problem is receiving more or less consideration by shipowners and operators.

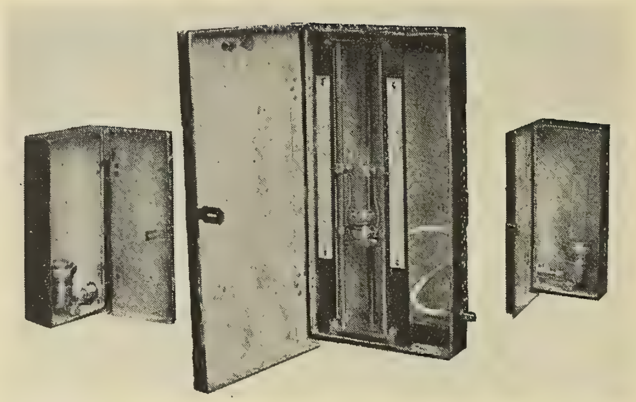
The latest equipment having the measuring of the depths of liquids in deep tanks as its object and which has proved successful on extensive trials is a combination of a tank gage and draft indicator with an averaging clinometer. These instruments are being produced by the A. A. Merrick Company, Inc., Philadelphia, Pa.

The outstanding features of this instrument are its accuracy, safety, simplicity, independence, reliability, ease of operation and the short time required for installation. To the owner it means a saving of money by enabling his engineer to order only as much high-priced oil as is required, and, by affording an accurate check on receipts, to avoid the usual "adjustment" after fueling. To the engineer it offers a clean and handy means of checking his receipts and consumption of fuel oil.

Operation of Tank Gage and Draft Indicator

The tank gage consists primarily of a glass connected at its upper end to a mercury U-tube having a scale graduated in feet and inches. From this connection at the upper end of the tube a ¼-inch pipe leads to a vacuum producer. This pipe is provided with a cock for opening and closing the line, and a second one for controlling the inflow and exhaust of air. A 1-inch pipe leads from the

Tank Gage and Draft Indicator



Averaging Clinometer with Trim and List Units

Typical Installation on Engine Room Bulkhead Within Reach of Watch Officer

bottom of the gage glass to the fuel oil manifolds or the cross connection pipes between manifolds, so that by opening the proper manifold valve the gage may be put in communication with any tank.

In explaining the theory of operation the device may be compared to two U-tubes. The first of these, of the commercial type containing mercury, carries a scale arranged in plain sight of the operator. The other tube consists of a gage glass, a 1-inch pipe below it, a cross connection, a manifold, an individual suction line to the tank, and the tank itself. One end of the mercury U-tube is always open to the atmosphere, as is also the tank through its air escape pipe.

The gage is usually secured in a position convenient for inspection. When it is installed, a point is established and marked on the glass, which is a given recorded distance above the bottom of the tank. By opening the proper manifold valve and varying the vacuum or pressure in the gage glass the oil from any tank may be brought to this mark and sustained there. The two U-tubes are thus brought into balance. The vertical height of mercury in the tube is a measure of the height of the oil, these being in the inverse ratio of their specific gravities. From this relation we may find the vertical height of oil sustained above its natural level in the tank. The difference between this value and the distance between the bottom of the tank and the mark on the glass (previously determined) is the depth of oil in the tank. The scale is graduated so that this depth may be read directly, while a separate scale is provided for each degree Baumé of oil.

If the ship is down by the head, for example, the forward double bottom tanks and the oil contained are lower in relation to the gage. The scale reading in this case would be less than the actual depth in the tank by the amount the center of the tank had been lowered. This amount is actually the fore and aft horizontal distance between the gage and the center of the tank multiplied by the sine of the angle of trim. Corrections for all angles of trim and list are computed for each gage.

Determining the Angles of Trim and List

For the purpose of keeping a constant record of the trim and list of a vessel, an averaging clinometer is provided. This device, consisting of three members, is usually fitted in a convenient corner of the engine room. The center or movable member of the device is secured in the corner, the second member 100 inches forward or aft of this, and the third member 20 inches inboard of the first. The fore and aft and transverse units are connected to the center member by ¼-inch pipes and three-way valves. Each of the tubes is partially filled with light oil which stands at a marked point in each of the glasses. If the three-way valve is turned so that the movable member and the fore and aft member are in communication and the ship goes out of trim, the liquid will rise or fall in the movable glass. This glass may be raised or lowered until the liquid attains its original level, and by this procedure the distance moved is a measure of the angle of trim and is read directly from the scale.

Listing is measured in a similar manner by putting the first and third members in communication. Clinometers are ordinarily adjusted to measure the trim accurately to within 0.02 degree and listing to 0.10 degree, but the instrument may be arranged for finer readings if desirable.

Both the gage and clinometer are accurate when the vessel is rolling or pitching. A ship in motion causes the liquid to move up and down both in the gage and the clinometer glass, but by choking down slowly on the 1-inch cock and the three-way valve the motion is damped until a correct average is obtained.

The one precaution necessary in taking readings on the gage is to be sure that the oil is brought to the mark on the glass and maintained until the scale is read. This is accomplished by manipulating the vacuum and air cocks to secure the desired results.

Vacuum Producer

Both vacuum and pressure are required in the operation of the gage—vacuum if the level of oil is below the mark on the gage glass and pressure when the level is above the mark, which is usually the case in settling tanks. When pressure is required it is produced by the oil itself, which in attempting to seek its own level compresses the air contained in the gage and is prevented from rising further, since this pressure kills the head of oil forming it.

Vacuum is produced by a 30-gallon cylindrical tank located 32 feet above the tank top. A ½-inch pipe runs from the bottom of this tank to the bilge where the end is covered by a water seal. The tank is filled with sea water from the sanitary system. When the tank is full (as shown by the overflow pipe) the filling pipe is closed, the overflow closed, and the drain pipe opened. The water in the water seal is under atmospheric pressure, while that in the tank is under no pressure at all. The vacuum line from the gage enters the top of this tank by a check valve, and this makes available for use in the gage what is practically a perfect vacuum. As the gage is used the vacuum is gradually relieved, and when it has fallen to the point where it will not draw oil into the gage glass it is necessary to refill the tank. All controlling valves are placed alongside the gage box.

A small leak in any of the connections does not affect the accuracy of the gage, as the air drawn in will bubble up into the glass and pass on to the vacuum producer. Should the leak become so great that the oil cannot be drawn into the glass, it must be stopped up, for in such a case the fuel oil transfer pump is not able to get the proper suction. In practice it is found that the individual tank suction lines, the manifolds and the cross connections are always full of oil except when the tank has been pumped dry so that it is not necessary to draw oil all the way from the tank to the gage.

The Economy of Water Transportation

BY SECOR CUNNINGHAM, JR.*

The organization of freight traffic throughout the country is becoming of increasing importance, particularly with the present shortage of rail transportation. Wherever possible, the inland waterways should be utilized to relieve the stress, especially when the operating costs of a river fleet are as favorable as in the carriage of bulk cargo such as the one described in the following article.

THEORETICAL figures seldom have been of much real value in arriving at accurate costs of operation. However, there are times when theoretical figures are the only ones obtainable and consequently we must use them if we wish to even approximate probable costs of doing business.

Suppose, for instance, that a large coal company transports three million tons of coal per year at a present cost of hauling from the St. Louis District to Chicago by rail of $1.50 per ton and that they would make it worth while for a transportation company to determine the probable cost of hauling this coal to Chicago by water.

Some of the figures in such an estimate must be theoretical, because at the present time no one is transporting three million tons of coal per year up the Illinois River and connecting canals, and therefore records of actual operating expenses are not available. Figures of reasonable accuracy may be arrived at, however, and then substantiated by figures of others who are operating under similar conditions. Anyone who is interested in water transportation is generally glad to learn of new projects in this line and will willingly give all possible assistance in determining probable costs.

The secretary of war under the date of March 4, 1920, issued a permit to the governor of Illinois authorizing him to proceed with the improvement of the Desplaines and Illinois rivers between Lockport and Utica, a distance of some 63 miles. Those who are most closely associated with this project believe that if this work is pushed the new waterway will be completed within about three years.

Although it may seem rather unusual to prepare figures, the practicability of which cannot be tested for three years, it must be realized that it will no doubt take considerable time for the investigating company in question to arrive at a decision on the matter. Furthermore, after such a decision is made the condition of the market will undoubtedly cause many unforeseen delays in the delivery of the necessary equipment. Therefore we can safely go ahead with the proposition and endeavor to collect all available figures.

Period of Navigation on Rivers

One of the items which affects this proposition to a great extent is the question of the number of days each year that the waterway will be navigable. An investigation, however, has shown that this item will vary from 240 to 270 days per year. It is felt that in view of this it is safe to assume that under normal conditions river operation can be carried on for an average period of 250 days each year. Based on this figure it will be necessary to bring into Chicago 12,000 tons of coal each of the 250 days in order to meet the required total of 3,000,000 tons per year.

Equipment Necessary for Project

In making a decision as to the type of equipment, there is little doubt as to the advisability of using towboats and barges in preference to a fleet composed of barges, a certain number of which are driven by their own power. While the latter fleet is sometimes advantageous for han-

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dling package freight, it is generally agreed that the former will prove more efficient for the hauling of coal. One of the chief reasons for this, of course, is the fact that in order to operate the fleet most economically, all units, and especially the power units, must be kept working for the greatest possible amount of time. In other words, it is less expensive to hold a plain barge at a dock for unloading than it is to hold a power barge which costs probably ten times as much money. The high rates of interest which it is necessary to pay make it highly desirable to get the greatest possible amount of work out of the investment during its operative life. This, of course, is true in any work, but is more especially true in reference to water transportation equipment which is so costly.

Towboats and Barges

The sizes of towboats and barges are directly dependent upon the dimensions of the locks and the stream itself. At present it is contemplated that the locks will be 600 feet long, 110 feet wide and have a minimum depth of 8 feet, and that at no point shall the stream itself be less than 160 feet wide or less than 8 feet deep.

With these dimensions as a guide, it has been decided that a barge with a carrying capacity of 750 tons will prove most efficient for operation on this waterway. The length of this barge would be approximately 160 feet, the width 34 feet and the depth 8 feet.

In order to determine the number of towboats and barges that will be needed, we must first estimate the running time for the round trip. As closely as can be determined at the present time, the average rate of current of the river will be two miles per hour. Assuming that boats are used which, when fully loaded, will travel six miles per hour in slack water, we are safe in saying that the average speed upstream will be at least three miles an hour. As to the speed downstream, it is fair to say that an average speed of six miles an hour can very easily be maintained. For the round trip between St. Louis and Chicago, we will then have an average of 4½ miles per hour. At this rate the time for the round trip of 730 miles would be 162 hours, or approximately seven days.

A towboat of 1,000 horsepower capacity can very readily tow nine 750-ton barges, or a total of 6,750 tons per trip. In order to carry 3,000,000 tons in a year, it would be necessary to make 444 trips. Therefore, as each boat could make but one round trip per week, or 36 trips per season, it will be necessary to have at least 13 towboats.

As to the number of barges, we can figure that we need nine barges for each towboat, nine at the docks in St. Louis and a similar number at the docks in Chicago. To this total of 135 should be added about fifteen barges as a safety factor against accidents and unforeseen delays.

Amount of Investment

A number of large manufacturers of boats and barges have been canvassed and it has been found that the price of a 1,000-horsepower towboat will not exceed $200,000, while a suitable type of barge can be purchased for $20,000. Thirteen towboats at the above price would cost $2,600,000, while 150 barges will amount to $3,000,000. To this must be added $200,000 to cover tugs, launches and other miscellaneous equipment which it will be necessary to have. We then have a total investment of $5,800,000.

Operating Expense

The three most important items of operating expense are wages, subsistence and fuel. As to the former, it is safe to say that with a crew of 16 men to a boat the monthly payroll per boat will be $2,400, or a yearly total for the entire fleet of thirteen towboats of approximately $375,000.

Subsistence will average $1.50 per man per day, and for 13 crews of 16 men each will amount to $115,000 per year.

As the company in question is in the coal business, the cost of coal can be figured at $2.25 per ton. Under average running conditions with a modern type of boat the coal consumption will not exceed 2 pounds per horsepower hour. We shall assume the running time at 90 percent and can then figure the annual fuel costs for 13 boats as follows:

$$24 \times 250 \times \frac{0.90 \times 1{,}000}{2{,}000} \times 2 \times 2.25 \times 13 = \$160{,}000.$$

In addition to the above items are the toll charges and other miscellaneous expense. Toll charges will amount to 5 cents per ton, or on 3,000,000 tons a total of $150,000 per year. Other miscellaneous expense such as oil, waste and general supplies will vary, but can be safely figured at $15 per boat per day. For thirteen boats we can figure the annual expense as follows:

$$250 \times 15 \times 13 \times 0.90 = \$48{,}000.$$

Summing up, the total operating expense will be $848,000 per year.

Overhead

The overhead expense will include the salaries of those in charge of the fleet, their assistants and also the necessary office and clerical force. It is estimated that an allowance of $50,000 per year will be ample to cover this.

Fixed Charges

The amount which should be allotted to fixed charges is, of course, subject to much discussion. Such items as the life of a boat and the upkeep expense during its life are very difficult to determine, but it is felt that an annual charge of 15 percent of the total investment is not excessive. This and the other fixed charges on the $5,800,000 investment are given below:

Depreciation and maintenance at 15 percent........	$870,000
Interest at 7 percent	406,000
Insurance at 5 percent	290,000
	$1,566,000

Total Expense

With an annual operating expense of $848,000, overhead of $50,000 and fixed charges of $1,566,000, the total expense chargeable to hauling 3,000,000 tons is $2,464,000 per year. The cost per ton therefore would be $.8213, or in round figures 82 cents per ton.

In order to make our figures comparable with the railroad rate between the mines and Chicago, we must add the cost of delivering the coal from the mines to the barges. The cost of hauling the coal from the mines to the river will not exceed 25 cents per ton, including taxes. The expense necessary to transfer the coal from the railroad cars to the barges, including fixed charges on tipples, will be approximately 10 cents per ton. We therefore have a total additional expense of 35 cents per ton.

Adding this to the cost of hauling the coal up the river, the total cost per ton from the mines to Chicago will be $1.17. With an all-rail rate of $1.50 per ton, it is seen that a saving of 33 cents per ton can be effected by using water transportation.

Why, then, if this form of transportation is so cheap, are we not using it to a greater extent? One immediate reason, of course, is that the present waterway from St. Louis to Chicago is not in such condition as to render coal transportation on a large scale profitable. The reason that is is not in proper condition at the present time is that those in whose possession has rested the power to improve this waterway have not, until recently, realized the absolute value and positive necessity of spending the requisite amount of money to improve existing conditions. Now that the work has been authorized, however, the next step for those who are interested in this project is to do all in their power to assist those in charge of the improvement to bring the work to completion at the earliest possible date.

One of the best ways to do this is to bring this matter to the attention of big shippers; show them how cheap is this form of transportation and show them how it can readily be adapted to their needs. This, more than anything else, will hasten the day of water transportation, for public sentiment and interest are the greatest possible stimuli to action.

Portable Stacking Elevator

Heavy Bales and Boxes Stacked at Low Cost by Electrical Device Developed at Seattle

GUNNY bales, weighing from 1,400 to 2,000 pounds, are received in large shipments on the piers of the Port of Seattle. So long as these did not need to be piled, no freight handling problem was involved because one man with a two-wheeled truck could deliver the bales at the desired places unaided and at a very low cost. As floor space became more valuable, however, it was necessary to pile the bales two high. The labor cost then increased enormously because it took ten men to lift the bales to the second tier.

A study of the problem undertaken by G. F. Nicholson, chief engineer, and G. Whitestone, electrical and mechanical engineer, of the Port of Seattle, resulted in the development of a portable stacking elevator, which has greatly reduced the cost of unloading cargo of this character. The device resembles a miniature motor-driven pile driver with a steel platform operated in the leads in place of a hammer, the entire apparatus being mounted on an electric truck. The truck is of a standard type operated by storage battery. When it is desired to use the truck separately the clamps which hold the steel frame to the truck body are removed and the pair of pivoted struts at the rear are swung down to bear on the floor. The truck can then be run out from under the elevator mechanism proper.

Construction of the Machine

The mechanism consists of an electric motor geared to a pair of drums on which are wound the hoisting cables that operate the platform. The gear ratio can be suited to the speed required. For handling gunny bales and general freight, a lifting speed of 60 feet per minute has been found suitable. The lifting capacity is about 3,000 pounds. The motor is served by an extension cord from the nearest outlet in the power circuit, but, if desired, a motor could be used which would be operated by the storage battery. The controller for the hoisting motor is provided with an automatic cut-off effected by a cable carrying adjustable stops. This arrangement shuts off the power and sets the brake at a predetermined point. The leads are hinged so they can be laid back to permit the machine to go through doorways. For use in narrow aisleways a turntable has been designed to be placed between the truck and elevator proper. This allows the elevator to be swung around at right angles to the truck, in which position it can handle freight equally well.

Portable Stacking Elevator Developed by Engineers at the Port of Seattle

Method of Operation

For handling gunny bales the machine is placed in the center of the shed floor and truckers with their two-wheeled trucks deliver the bales to the machine platform. In this way the machine can work as many as six piles at a time. The steel platform comes to rest on the floor, and onto this the man with the two-wheeled truck dumps his load without help. The platform then elevates the bale, the machine is moved to the desired location and the platform thrust over the lower tier of bales. While the bale is held in position over the pile the machine backs off. To aid further in finally placing the bale, the platform is slightly elevated and pushed against the bale while the men guide it into place. This operation is very rapid and is said to eliminate at least six men from each crew engaged in putting gunny bales on the second tier. The machine also makes it possible to extend the piles several tiers, if desired, at practically the same cost as for the second tier. Piling gunny bales in three tiers by man power would be impracticable because of the excessive labor cost, but with the machine higher tiering is possible.

An ordinary storage battery truck in this service is found to operate approximately 12 hours without recharging. When a direct current motor is used on the elevator and draws energy from the truck battery, the length of service for each recharge is reduced by about 25 percent. However, the use of a motor connected to the storage battery is recommended by the Port of Seattle authorities because it eliminates the extension cords and the need for power wiring.

Savings Effected

When the first stacker was put in operation on a gunny bale cargo a record of cost data showed a saving of about one-half over the usual cost of handling the bales. The cost of unloading this cargo was $5,000. If five stackers had been available, one for each of the vessel's five hatches, port authorities stated that the cost would have been reduced to $2,500. Enough machines are to be added to the two now in service to permit of an entire cargo being handled by this means.

The machine has been effectively used for stacking canned salmon with the aid of four wheel trailers on which the salmon cases are loaded. A light wooden bottom is placed first and the stack piled on this. These trailers are loaded at the side of the ship and drawn by electric trucks to the stacker. The steel platform of the elevator is run underneath the wooden bottom and the load lifted to the desired height, where the cases are removed by hand. This method releases the trailer as soon as it reaches the stacker and is relieved of its load.

Shipbuilding in American Shipyards

Steel Vessels Under Construction for Private Account—Total Construction of Merchant Tonnage

In the shipbuilding industry the transition from a wartime to a peace basis was delayed months after a similar change took place in the other major industries in the country whose energies were devoted almost wholly to military uses during the war. As a matter of fact, the shipbuilding programme undertaken by the Government to meet war needs will not be completed until the end of the present year.

Ships for Private Account

On account of the fact that at the time the Armistice was signed practically the entire shipbuilding capacity of the country was taken up with both merchant and naval work for the Government, it was some months later before facilities became available for the production of steel tonnage for private account. It was not until November, 1919, a year after the Armistice was signed, that any appreciable amount of tonnage was delivered from American shipyards to private owners.

From that time on the delivery of steel vessels to private owners has steadily increased, and as building ways in the shipyards have become available through the completion of Government contracts, an increasing number of contracts from private shipowners have been placed with the shipbuilders so that at the present time the volume of construction for private ownership exceeds that for the Government. According to figures compiled from the records of the American Bureau of Shipping, Lloyd's Register of Shipping and the Shipping Board there were under construction for private account on September 1, 1920, 383 steel merchant vessels of 1,438,498 gross tons as against 166 vessels of approximately 1,049,750 gross tons for the Shipping Board, making a total merchant shipbuilding programme on that date of 549 vessels, aggregating 2,488,248 gross tons.

Oil Burning Vessels Predominate

As far as the steel ships building for private account are concerned 75 per cent of the total tonnage is under construction on the Atlantic and Gulf coasts, 21 percent on the Pacific coast and 4 percent on the Great Lakes. The ships building for private account are divided roughly into two classes—cargo vessels and oil tankers, 43 percent of the total being cargo vessels and 57 percent tankers. All of the tankers are oil burning vessels and 78 percent of the cargo steamships are oil burners, so that oil burning vessels comprise 91½ percent of the total steam tonnage under construction for private account.

Before the war there were in the United States only 38 shipyards with 160 ways equipped for building steel vessels. During the war the number of ways in the original 38 yards was increased to 281 or an increase of 78 percent. At present, the number of shipyards in the country equipped for building steel vessels totals 66 and these yards have a total of 455 ways.

Shipbuilding Outlook Promising

Owing to the completion of Government contracts, 33 percent of the building ways are now idle, but, in most cases, the idle ways will be found in the new shipyards which were established during the war, the future of which was problematical. On the other hand, there are approximately 175 vessels on order in the older shipyards, keels of which have not yet been laid, due to the fact that ways are not yet available in the yards for laying down new work. Thus it will be found that while many of the

TABLE I.—STEEL MERCHANT VESSELS BUILDING IN THE UNITED STATES, SEPTEMBER 1, 1920.

	Number	Gross Tons
For private account	383	1,438,498
For Shipping Board	166	1,049,750*
Total	549	2,488,248

* 1,574,625 deadweight tons.

TABLE II.—STEEL VESSELS BUILDING IN THE UNITED STATES FOR PRIVATE ACCOUNT ON SEPTEMBER 1, 1920.

Cargo Vessels	Number	Gross Tons
Coal Burning	20	38,171
Oil Burning	105	425,455
Coal and Oil Burning	13	74,567
Non-propelled	109	82,350
Total	247	620,543
Tankers		
Oil Burning	117	805,964
Non-propelled	19	11,991
Total	136	817,955
Grand Total	383	1,438,498

newer yards, after completing their war contracts, are closing up, the major portion of the steel shipbuilding industry, comprising the old well-established yards on the seacoast, whose capacity has been vastly increased since the war began, is running at capacity with sufficient work on hand to keep the yards busy for months to come.

Coupled with the merchant tonnage already in hand, amounting to nearly two and a quarter million gross tons, the shipbuilders are also busy with a large volume of naval construction, much of which cannot be completed inside of two years and which will bring the total volume of vessels under construction well over three million tons. Added to this there is in prospect the construction of a large fleet of passenger vessels—a class of construction that was almost wholly neglected during the war and the need for which is very urgent. Several of the largest

TABLE III.—STEEL VESSELS STILL TO BE COMPLETED FOR THE UNITED STATES SHIPPING BOARD, SEPTEMBER 1, 1920.

Deadweight Tonnage	Number of Vessels	Total Deadweight Tonnage
13,000	26	338,000
12,500	1	12,500
12,000	7	84,000
11,800	2	23,600
11,375	1	11,375
11,000	5	55,000
10,300	2	20,600
10,200	4	40,800
10,100	5	50,500
10,000	8	80,000
9,600	11	105,600
9,500	4	38,000
9,400	18	169,200
9,000	20	180,000
8,800	8	70,400
8,800	2	17,600
8,000	11	88,000
7,500	14	105,000
7,400	2	14,800
6,000	2	12,000
5,500	1	5,500
5,350	4	21,400
5,000	3	15,000
4,050	3	12,150
1,800	2	3,600
	166	1,574,625*

* 1,049,750 gross tons.

steamship companies have already had plans prepared for various types of combined cargo and passenger ships, contracts for which will undoubtedly be placed in the near future. Among these companies are the International Mercantile Marine, the Matson Navigation Company, the Red D and the Munson lines.

As the majority of recent contracts placed by private owners has been for oil tankers it is apparent that the demand for this class of tonnage has by no means ended. As a matter of fact it is reliably reported from authorities in the oil industry on the Pacific coast that a fleet of tankers twice the size of the present fleet now operating on the Pacific will be needed during the next two years to meet the requirements for handling oil.

In other branches of the shipbuilding industry such as yacht and small boat building and more especially in ship repairing, the volume of business in hand and in prospect is very encouraging.

TABLE IV.—STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT SEPTEMBER 15, 1920

Builders	Owners	Type	Gross Tonnage	No.	Total Tonnage
American Bridge Company	Portland Cement Company	Barge	300	3	900
American Bridge Company	Bell Iron Works	Barge	600	40	24,000
American Bridge Company	Standard Oil Company	Barge	500	4	2,000
American Bridge Company	U. S. Railroad Administration	Barge	900	25	22,500
American Bridge Company	U. S. War Department	Barge	350	6	2,100
American Shipbuilding Company		Freighter	2,338	4	9,352
American Shipbuilding Company		Freighter	7,700	3	23,100
Baltimore Dry Dock and Shipbuilding Company	Builders	Tanker	6,000	2	12,000
Baltimore Dry Dock and Shipbuilding Company	Builders	Freighter	4,311	2	8,622
Bath Iron Works	Crowell & Thurlow	Freighter	6,250	1	6,250
Bath Iron Works	Crowell & Thurlow	Freighter	6,253	1	6,253
Bayles Shipbuilding Company	Nyack Shipbuilding Company	Tanker	950	1	950
Bethlehem Shipbuilding Company:					
Fore River	Atlantic Gulf & West Indies Company	Tanker	7,800	1	7,800
Fore River	Sinclair Navigation Company	Tanker	6,600	2	13,200
Fore River	Standard Transportation Company	Tanker	7,800	2	15,600
Fore River	Standard Transportation Company	Tanker	7,794	2	15,588
Harlan Plant	Sinclair Navigation Company	Tanker	7,077	2	14,154
Harlan Plant	Sinclair Navigation Company	Tanker	4,500	2	9,000
Moore Poant	International Products Company	Refrig. Str.	3,500	2	7,000
Moore Plant	Western Maryland Railroad	Car Floats	1,200	2	2,400
Moore Plant	Standard Oil Company of N. Y.	Oil Barge	1,200	3	3,600
Sparrows Point	Ore Steamship Company	Tanker	13,500	1	13,500
Sparrows Point	Lux Navigation Company	Tanker	5,845	2	11,690
Sparrows Point	International Petroleum Company	Tanker	13,500	1	13,500
Sparrows Point	Atlantic Gulf & West Indies Company	Tanker	7,800	2	15,600
Sparrows Point	Standard Transportation Company	Tanker	6,900	1	6,900
Sparrows Point	Standard Transportation Company	Tanker	7,500	1	7,500
San Francisco	General Petroleum Corporation	Tanker	7,060	1	7,060
San Francisco	Pan American Petroleum & Transportation Company	Tanker	7,060	2	14,120
San Francisco	Standard Oil Company of California	Tanker	7,060	1	7,060
San Francisco	Standard Oil Company of California	Tanker	8,650	1	8,650
San Francisco	Standard Transportation Company	Tanker	7,060	1	7,060
Brunswick Marine Corporation	R. L. Smith	Freighter	1,250	1	1,250
Clinton Shipbuilding and Repair Company	A. C. Churchman	Tug	75	1	75
Clinton Shipbuilding and Repair Company	Union Petroleum Company	Barge	1,300	1	1,300
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Lightship	310	1	310
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Lightship	825	1	825
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Tender	875	2	1,750
Wm. Cramp & Sons Ship and Engine Building Co.	Florida East Coast Railway	Freighter	2,406	1	2,406
Wm. Cramp & Sons Ship and Engine Building Co.	Peninsula and Ocean Steamship Company	Pasa. & Cr.	2,000	1	2,000

TABLE IV.—STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT SEPTEMBER 15, 1920.

Builders	Owners	Type	Gross Tonnage	No.	Total Tonnage
Oscar Daniels Company	Standard Oil Company of N. J	Tanker	7,800	2	15,600
Downey Shipbuilding Company	Southern Pacific Company	Freighter	3,850	3	11,550
Downey Shipbuilding Company	Mexican Petroleum Company	Oil Car.	550	1	550
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	273	4	1,092
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	1,500	15	22,500
Dravo Contracting and Construction Company	Keystone Sand and Supply Company	Barge	500	9	4,500
Duthie, J. F	Coastwise Steamship Company	Freighter	1,500	2	3,000
John Eichleay Company	United States Engineers	Towboat	200	1	200
Federal Shipbuilding Company:					
Kearny, N. J	War Department	Barge	350	(see American Bridge Co.)	
Kearny, N. J	Freeport Sulphur Company	Freighter	4,127	1	4,127
Kearny, N. J	Sinclair Navigation Company	Barge	500	3	1,500
Kearny, N. J	Standard Oil Company	Tanker	10,000	5	50,000
Kearny, N. J	Mexican Petroleum Company	Barge	450	4	1,800
Kearny, N. J	United States Steel Corporation	Freighter	6,000	6	36,000
Chickasaw, Ala	Builders	Freighter	6,869	1	6,869
Chickasaw, Ala	United States Steel Corporation	Freighter	6,000	10	60,000
Geo. A. Fuller Company	Builders	Freighter	6,121	4	24,484
Globe Shipbuilding Company	Builders	Freighter	5,700	2	11,400
Great Lakes Engineering Works	Horace E. Dodge	St. Yacht	600	1	600
Greenport Shipbuilding Company	Bay State Fishing Company	Trawler	292	2	584
International Shipbuilding Company	Marine and Commerce Company	Freighter	4,200	4	16,800
Johnson Iron Works	Cortex Oil Corporation	Der. Barge	200	1	200
Johnson Iron Works	Builders	Barge	200	3	600
Kyle & Purdy	East Coast Fisheries	Trawler	670	2	1,340
Kyle & Purdy	Max Fleischman	Yacht	250	1	250
Lawley & Son, Geo	Edgar Farnum	Aux. Yacht	350	1	350
Lawley & Son, Geo	Mr. Crane	St. Yacht	150	1	150
Long Beach Shipbuilding Company	California Mexican Company	Freighter	200	1	200
Manitowoc Shipbuilding Company	Atlantic Fruit Company	Fruit Str.	1,600	1	1,600
Manitowoc Shipbuilding Company	Builders	Freighter	2,712	3	8,136
McDougall-Duluth Company	Sugar Products Company	Freighter	2,338	3	7,014
Merchant Shipbuilding Corporation	Union Oil Company (Del.)	Tanker	6,250	2	12,500
Merchant Shipbuilding Corporation	American Hawaiian Steamship Company	Freighter.	7,800	2	15,600
Merchant Shipbuilding Corporation	Shawmut Steamship Company	Freighter	7,300	2	14,600
Merchant Shipbuilding Corporation	Cochran Harper Company	Tanker	6,250	2	12,500
Merchant Shipbuilding Corporation	Tidewater Oil Company		.....	2	..
Moore Shipbuilding Company	Matson Navigation Company	Freighter	9,500	2	19,000
Moore Shipbuilding Company	Standard Oil Company of California	Tanker	3,250	1	3,250
Moore Shipbuilding Company	Standard Oil Company of New Jersey	Tanker	7,000	3	21,000
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,000	1	7,000
Moore Shipbuilding Company	Southern Pacific Company	Tanker	9,600	1	9,600
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,089	1	7,089
National Shipbuilding Company	French Owners	Collier	1,371	6	8,226
National Shipbuilding Company	Cuyamel Fruit Company	Fruit St.	300	4	1,200
National Shipbuilding Company	Pan American Petroleum Company	Tanker	1,371	1	1,371
Newburgh Shipyards, Inc	Cuyamel Fruit Company	Freighter	3,000	2	6,000
Newburgh Shipyards, Inc	Union Sulphur Company	Freighter	4,700	2	9,400
New Jersey Dry Dock Company	East Coast Fisheries	Trawler	355	2	710
Newport News Shipbuilding & Dry Dock Company	Atlantic, Gulf & West Indies Company	Tanker	10,600	2	21,200
Newport News Shipbuilding & Dry Dock Company	Standard Oil Company of New Jersey	Tanker	13,500	2	27,000
New York Shipbuilding Corporation	W. R. Grace & Company	Tanker	9,340	1	9,340
New York Shipbuilding Corporation	United Fruit Company	Tanker	6,800	2	13,600
New York Shipbuilding Corporation	Standard Transportation Company	Tanker	7,794	4	31,176
New York Shipbuilding Corporation	Munson Steamship Company	Freighter	6,000	1	6,000
New York Shipbuilding Corporation	Builders	Tanker	6,800	2	13,600
Northwest Bridge & Iron Company	Swiftsure Oil Transportation Company	Tanker	9,000	7	63,000
Pacific Coast Shipbuilding Company	Associated Oil Company	Motor Tk.	188	1	188
Pacific Coast Shipbuilding Company	Associated Oil Company	Tanker	1,000	1	1,000
Pensacola Shipbuilding Company	Morris Adler	Tug	300	1	300
Pusey & Jones Company	Philadelphia & Reading R. R	Pas. Ferry	773	2	1,546
Pusey & Jones Company	Eastern Steamship Company	Freighter	2,700	1	2,700
Rice Bros	Atlantic Coast Fisheries	Trawler	400	4	1,600
Southwest Shipbuilding Company	Luckenbach Steamship Lines	Freighter	6,100	1	6,100
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	8,650	2	17,300
Southwest Shipbuilding Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	4,788	1	4,788
Spedden Shipbuilding Company	Standard Oil Company of N. J	Barge	995	1	995
Spedden Shipbuilding Company	Builders	Tug	325	1	325
Standard Shipbuilding Corporation	Cuyamel Fruit Company	Fruit Str.	900	2	1,800
Standard Shipbuilding Corporation	Eagle Oil Transportation Company	Tanker	5,600	4	22,400
G. M. Standifer Construction Company	Standard Oil Company of New Jersey	Tanker	8,250	3	24,750
G. M. Standifer Construction Company	Imperial Oil, Ltd	Tanker	8,250	2	16,500
Staten Island Shipbuilding Company	Galena Signal Oil Company	Tanker	2,500	1	2,500
Staten Island Shipbuilding Company	American Sugar Refining Company	Tanker	4,200	1	4,200
Staten Island Shipbuilding Company	Standard Oil Company of New York	Barge	420	6	2,520
Staten Island Shipbuilding Company	Standard Oil Company of New York	Mot. Barge	450	1	450
Staten Island Shipbuilding Company	Tidewater Oil Company	Tanker	1,200	1	1,200
Submarine Boat Corporation	Builders	Freighter	3,545	16	56,720
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	9,000	4	36,000
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	6,700	1	6,700
Sun Shipbuilding Company	Pan American Petroleum & Transportation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Sinclair Navigation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Standard Oil Company of New Jersey	Tanker	6,800	2	13,600
Sun Shipbuilding Company	Union Oil Company	Tanker	9,000	2	18,000
Sun Shipbuilding Company	Societe Anonyme d' Oriente d' Industre	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Tidewater Oil Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Norwegian American Line	Tanker	6,800	1	6,800
Tank Shipbuilding Corporation	Southern Oil and Transportation Company	Barge	835	1	835
Tank Shipbuilding Corporation	Sunset Fuel Oil Company	Oil Barge	1,250	1	1,250
Terry Shipbuilding Corporation	U. S. Mexican Oil Transportation Company	Tanker	5,190	3	15,570
Texas Company	Builders	Tanker	6,700	5	33,500
Texas Company	Builders	Mot. Tan.	3,500	1	3,500
Texas Company	Builders	Barge	750	3	2,250
Todd Shipyards Corporation (Tebo Yacht Basin)	Donald Steamship Company	Freighter	1,400	2	2,800
Todd Dry Dock & Construction Company	Stock	Freighter	4,600	1	4,600
Toledo Shipbuilding Company	Stock	Freighter	2,559	1	2,559
Union Shipbuilding Company	Builders	Freighter	7,150	4	28,600
Union Shipbuilding Company	Gulf Refining Company	Tanker	6,700	2	13,400
Union Construction Company	General Petroleum Company	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Motor Tk.	1,650	1	1,650
Union Construction Company	Shell Oil Company	Tanker	7,000	1	7,000
Union Construction Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Virginia Shipbuilding Corporation	United States Steamship Company	Freighter	6,060	3	18,180
Total				396	1,449,859

Giving Effect to the Merchant Marine Act

BY WALDON FAWCETT

With only the nucleus of a Shipping Board to shoulder the responsibility, and with impulse to mark time on the formulation of all administrative policies until after the Presidential election in November, effect is nevertheless gradually being given to some of the most important provisions of the new Merchant Marine Act. It is significant that the features of the national maritime programme that have been the first to be formulated are those that have most direct and immediate contact with the practical side of the shipping and shipbuilding industry.

BY reason of possible influence upon private credit policies and terms in the shipbuilding industry, there is interest, aside from its obvious application, in the new ship sales policy formulated by the Shipping Board. The Board construed itself to be charged, under the provisions of the new act, with the duty of adopting and executing a ship sales policy that would, in fact, establish the merchant marine of the United States upon a sound operating and financial basis. To that end the Board undertook a careful survey of conditions in the maritime field with respect to costs of operation, current revenue, competitive conditions, present and prospective, and the bearing upon the waterborne transportation interests of the general financial and economic situation.

Ship Sale Plan

In the light of disclosures and conclusions reached, the Shipping Board evolved its ten-year sales plan for vessel property. Under this system a purchaser of new steel tonnage is under the necessity of paying in cash at the time of the delivery of the vessel only 10 percent of the purchase price. At the expiration of a period of six months after delivery of the vessel there is due a payment of 5 percent. Thereafter at intervals of half a year there are due similar payments of one-twentieth of the purchase price, the discharges of the obligations thus being spread, it will be noted, over a period of ten years. All deferred payments carry interest at the rate of 5 percent.

The arrangements for segregating the income of tonnage purchased from the Government on this plan will doubtless prove of interest to shipping men, even though they have no intention of making purchase in this quarter. All revenues derived from vessel operation, in the case of craft acquired on the installment plan, are to be deposited in a controlled or supervised account. From this account all payments upon the tonnage may be paid as they become due, except, of course, the initial payment which the buyer is required to raise strictly upon his own resource, as though in testimony to his responsibility.

Dividends

By way of net profit or dividend upon the operation of vessel property, the gross income of which is to be held as above indicated, a purchaser is to be permitted to take from the proceeds of operation, after the current installments are paid, a sum not exceeding 15 percent upon paid-up installments, this withdrawal to constitute a dividend upon the investment and to be distributed to the stockholders of the purchasing corporation in any manner that may be agreeable to the shareholders. When 50 percent of the purchase price has been paid, the buyer of tonnage is to execute a preferred mortgage on the property to the Shipping Board and thereafter the operation of the vessel is released from the supervision and control of the Board, except as to maintaining berth and route. The obligation of the vessel owner still holds also, of course, with respect to the scheduled payments of principal and interest at semi-annual intervals.

Awaited with especial curiosity by the shipbuilding industry was the price that the Shipping Board should fix on its tonnage for sale. The subject of the minimum price per ton to be asked was discussed at the greatest length, it may be recalled, in hearings conducted earlier in the year by the Merchant Marine Committees of the Senate and House of Representatives. Shipping men and shipbuilders were quizzed in detail as to the degree of disregard which Uncle Sam should, in reselling, show for the contract price (in excess of $200 a ton) which had been paid on war-time commitments and as to the prices that might be expected to prevail on new tonnage as the industry settled back into its stride after post-war readjustment. In the degree in which the Board's basic price should constitute either a compromise or an anticipation of future price conditions has there been curiosity with respect to the quotations to be named. The figures, as announced, ranging from $160 to $185 per ton, with a uniform differential of $10 per ton for oil burners over coal burners, bear evidence of an attempt on the part of the price fixers to strike a medium between the estimates made by consulting experts.

Prices Asked

A minimum price of $175 per deadweight ton for coal burners and $185 for oil burners has been named for three classes of vessels. These comprise, respectively, the American International Ship Building Corporation type, of 7,800 deadweight tons; the Skinner & Eddy type, of 8,800 deadweight tons, and the Skinner & Eddy type with a range of 9,600 to 10,067 tons. Lumped with the latter, at the price indicated, are all other vessels over 10,000 deadweight tons excepting combination cargo and passenger vessels, oil tankers and refrigerator vessels. Price pegged at $160 per deadweight ton for coal burners and $170 for oil burners are two groups of vessels, viz., those built on the Great Lakes for ocean service and the Submarine Boat Corporation type, as it is popularly designated, with a tonnage of 5,350. The reader will, of course, understand that it is the policy of the Shipping Board to entertain bids on the various types, sizes and classes of vessels, with awards going presumably to the highest bidder who is able to offer full and satisfactory evidence of financial ability to meet obligations as they become due. The prices named are designed to stand as minimums below which no bids would be entertained.

Deduction for Depreciation

The fixed prices must, manifestly, be made subject to deduction for depreciation, and because the question of consistent allowances for depreciation is always an interesting topic in shipping and shipbuilding circles, and doubly so in the face of the current marine insurance situation, the policy of the Shipping Board on this score was awaited expectantly. The conclusion of the Board is that deduction for depreciation should be allowed at the rate of 6 percent per annum for the second year of the vessel's age and 5 percent per annum for every year thereafter to date of purchase, depreciation to be allowed for whole months only and up to the estimated dates of delivery.

Of importance to shipping and shipbuilding interests has been the action of the Shipping Board looking to the extension to owners and operators of vessels of the privileges vouchsafed to them by Section 23 of the Merchant Marine Act. This is the section of the law that seeks to encourage the upbuilding of the United States merchant marine by the experiment of affording relief from Federal taxes. The section of the law above cited allows owners and operators of vessels documented under the laws of the United States and engaged in foreign trade in reporting net income to make a deduction, while the vessel is so operated, for each of the ten taxable years, beginning with the first taxable year ending after the passage of the Merchant Marine Act, of an amount equivalent to the net earnings of the vessel during the year.

Section 23 of the Jones Act

What will constitute "net earnings" within the meaning of this section of the law will probably require time to work out. There has been delay in the promulgation of the basic rules and regulations, and with these in force the disposition of a certain number of test cases will doubtless be required to establish the precedents that will serve for guidance. In the meantime, however, shipping interests are moving to take advantage of the exemptions promised. Among the applications already filed and considered in order are those of the Crowell & Thurlow Steamship Company, of Boston; W. R. Grace & Company, of New York, and the Pacific Mail Steamship Company.

It is stipulated in that section of the Merchant Marine Act which gives relief, as indicated, from taxes that the waiver is to be made only in the event that the exempted owner or operator shall deposit in a trust fund a sum equivalent to the war profits and excess profits taxes which he escapes. The trust fund referred to is, in each instance, to be devoted to the construction in shipyards of the United States of new vessels of a type and kind approved by the Shipping Board. In this last we have an important detail of the current activity. The companies above indicated and several others have filed data as to the types of vessels that they intend to construct with the funds that might be accounted a tax rebate.

New Shipbuilding Contracts Encouraged

The New York Shipbuilding Corporation is designated as beneficiary of this new stimulus to shipbuilding in two instances. W. R. Grace & Company has communicated intention to place a contract with the New York Company for a 10,000 deadweight ton oil tanker, and the Pacific Mail Steamship Company will entrust the same yard with a contract for an oil tanker of 9,800 tons deadweight. The Crowell & Thurlow Company obligates itself to put the equivalent of its remitted taxes into two cargo steamers of about 4,400 tons deadweight to be laid down at the Bath Iron Works, Bath, Me. The Sun Company, of Philadelphia, seeks to divert its Federal tax tolls to the construction by the Sun Shipbuilding Company, at Chester, Pa., of a single screw bulk oil steamer of about 12,000 tons deadweight and the Newcastle Shipbuilding Company, of Newcastle, Me., has sought sanction from the Shipping Board of a five-masted schooner now under construction as a type of vessel worthy of the investment of trust funds set aside in accordance with the indulgences of the new law. That there is no discrimination against schooners as fit subjects for the exercise of the authority conferred under Section 23 is attested by the fact that the Shipping Board has indeed already approved under this stipulation, the plans of the five-masted schooner above referred to and which is building to the account of the Boston Maritime Corporation, Boston, Mass., and Richard Diebold, of Newcastle, Me.

The most ambitious undertaking in quest of the benefits promised by Section 23 is that of the Standard Transportation Company, of 26 Broadway, New York, which undertakes to add to its fleet ten oil tank steamers. Four of these steamers, each of 12,620 tons deadweight, will be constructed by the Bethlehem Shipbuilding Company, at Quincy, Mass., and four tankers of like tonnage will be built by the New York Shipbuilding Corporation, at Camden, N. J. In addition, the Bethlehem Company undertakes two tank steamers of 10,000 tons each, one at its Sparrows Point, Md., yard and the other at the Union plant at San Francisco.

American Classification Promoted

That the Shipping Board intends to lose no opportunity to further its policy, as already revealed, with respect to American facilities for classification, was disclosed incident to the approval of the application of the Standard Transportation Company. In approving the plans of the ten vessels thereby authorized the Board decided that they should be constructed to meet the classification requirements of the American Bureau of Shipping. It is understood that this requirement will henceforth be a condition of the extension, in any instance, of approval as required by Section 23. This is but part and parcel of what appears to be a determined policy in behalf of the Americanization of the United States merchant marine. Readears are perhaps familiar with the appeal recently issued to insurance interests in behalf of the development of American resources in marine insurance, and coincident with this is the drive of the Shipping Board, through the operators and managers of Shipping Board vessels, to induce the fullest employment of our own nationals. In this connection it is announced that the statistics of the Sea Placement Bureau of the Shipping Board show that an average of six out of every ten men now entering the service of vessels under Shipping Board control are American citizens. To replace all foreigners by Americans will be, it is declared, a studied policy in so far as it may be carried out without delaying operations or crippling vessels for lack of American crews.

Relations with Foreign Countries

With the Shipping Board proceeding, step by step, to work out the practical policies prescribed by the new Merchant Marine Act, there has been injected more and more conspicuously into the situation an element of "politics" due to the reaction in various maritime nations to what are commonly known as the "preferential clauses" of the Jones Act. A spirit of competition, if not of resentment, has been quickened in various foreign quarters not less by the discriminatory features of this nation's new arrangements than by the circumstance that a programme of team-play has been perfected between the American Ship & Commerce Corporation and the Hamburg-American Line. For American shipping and shipbuilding interests the significance of this compact is that it places at the disposal of American interests all the technical knowledge and experience of what was, before the war, the premier steamship company of the world, yet gives to the United States first call in supplying tonnage for service on all of the Hamburg-American Company's old trade routes and in no event permits German participation to extend beyond 50 percent of the tonnage in either freight or passenger service.

Beginning with his correspondence with C. J. France, of Seattle, Wash., Admiral W. S. Benson, chairman of the Shipping Board, has shown no disposition to ignore criticism nor dodge the issue precipitated by Section 28 of the new law, the purpose of which, as Admiral Benson conceives it, "is to build up the American merchant marine by protecting United States ports in the enjoyment of an export traffic moving in American ships and to offset the countless discriminations by other nations against American shipping." While frankly ready to join the issue, the head of the Shipping Board will not allow the official attitude to be represented as unduly drastic.

Shipping Board Prepared to Meet the Issue

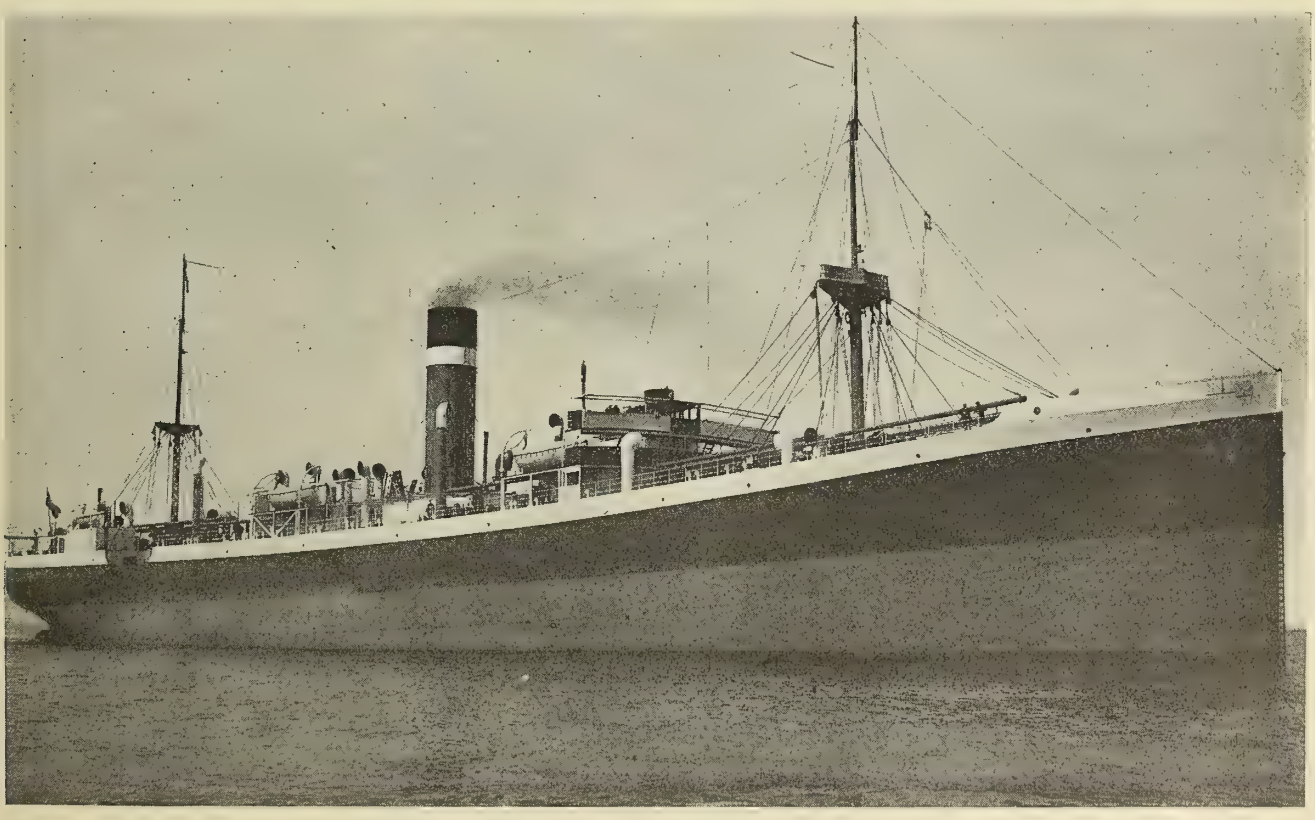
He insists, for example, that it is not the purpose of the Shipping Board, in the legislation it has furthered, to give them such advantages as would offset foreign advantages and permit them to carry at least a considerable portion of the commerce between the United States and foreign countries. In dealing with the situation at Seattle, moreover, Admiral Benson has made it anything but difficult to read between the lines of a statement in which he has said that the Shipping Board, in allocating and operating its vessels, must be assured of the loyal support of the home ports from which they are to operate. Domestic discussion of the effect of Section 28 of the Merchant Marine Act has been intensified, naturally, by the delay beyond the prescribed ninety-day period of notification to foreign governments of the intention of the United States to revoke certain clauses of existing commercial treaties. Some twenty-five treaties are affected and it is intimated that the period allowed by law afforded none too much time for the careful analysis of these instruments on the part of the Department of State.

Fruitful of speculation as indicative of the play of inside administrative "politics" in the Shipping Board have been the changes recently announced in the legal annex of the Board. The outstanding feature of this change is the combination, under one head, of the legal departments of the Shipping Board and the Emergency Fleet Corporation, which have heretofore been kept separate and distinct. The Admiralty Department will, owing to the nature of its work, be kept separate in the future as in the past from the Legal Department. That a sequel of the reorganization of the Legal Department will be found in the abolishment of the Bureau of Investigation is a contingency of definite interest to shipbuilders and ship equipment and supply firms, inasmuch as it has been depended upon to pave the way for the payment of thousands of long-standing claims against the Government. If there is to be a slowing down of the operation of the claims department the outlook is anything but encouraging to firms that desire to close up accounts.

Cargo Steamer City of Brisbane Built for the Ellerman Lines, Ltd.

ANOTHER fine cargo boat has just been added to the fleet of the Ellerman Lines, Ltd., of Liverpool, for their Hall Line service to India. This is the *City of Brisbane*, built to Lloyd's highest class by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne.

The ship, which has a cruiser-shaped stern, is to carry about twelve thousand tons deadweight on a draft of 27 feet 10 inches. Her chief dimensions are: Length between perpendiculars, 462 feet 9 inches; extreme beam, 58 feet 5 inches; molded depth, 33 feet 5 inches. The main engines, built by the Wallsend Slipway & Engineering Company, Ltd., consist of double reduction geared turbines of the Brown Curtis type, which drive a single propeller. The four boilers working under forced draft also come from the shops of the engine builders.



Steamship *City of Brisbane* Recently Added to the Ellerman Lines, Ltd.

Custom House and Dock at Puerto Cabello, One of the Deepest Harbors on the Western Hemisphere

Shipbuilding and Shipping in Venezuela

BY HARRY CHAPIN PLUMMER

SHIPBUILDING and ship repairing, ship chandlery and the maritime trades along the Venezuelan coast are on the rapid increase and have been since the outbreak of the world war, which forced the northernmost of the South American republics to fall back upon her own not inconsiderable resources for the provision and upkeep of such tonnage, both steam and sail, as she required for her swiftly developing coastal trade and her commerce by sea to the nearby republics of Colombia and Panama and to Cuba and the American, Dutch, English and French West India Island possessions.

Harbors and Navigable Rivers

Not only has Venezuela a magnificent coast line of hundreds of miles on the open Caribbean, and that includes many excellent natural harbors, but the broad Orinoco, with its uninterrupted deep channel flowing through the Delta to the sea constitutes one of the world's finest inland waterways. It is from Ciudad Bolivar, the populous city on the north bank of the famous stream, that much of the country's large export trade with Trinidad is conducted, and so active and constant is the intercourse between Ciudad Bolivar and Port of Spain, the seaport and capital of Trinidad, that English is spoken at the Orinoco port as a second language. When one encounters a native resident of Ciudad Bolivar at Caracas, the capital city of Venezuela, or elsewhere in the interior, it proves to be the rule rather than the exception that he speaks English and, more often than not, speaks it fluently.

Tables I and II will convey an idea of the extent of the newly developed maritime trade of Venezuela, a chief factor in which has been the construction by the Venezuelan government, almost entirely since the beginning of the war, of a superb system of motor highways which now connect such port cities as La Guaira, Puerta Cabello Carupano and Cristobal Colon with Caracas, Valencia, the highland industrial city 115 miles westward of the capital, Barquisimeto, Cumaná, Barcelona and the more distant colonial cities in the Cordilleras of the Andes, such as Merida, Tachira, Trujillo and San Cristobal.

Interior Trade Routes Revolutionized

The new network of roads naturally has revolutionized the interior trade routes of the country, which hitherto were confined to "old Spanish trails," mere paths for oxen, and, in the mountain regions, for pack burros and their drivers walking in single file. The consequent rerouting of such important major products of Venezuelan

TABLE I.—MARITIME TRAFFIC BETWEEN CHIEF PORTS OF VENEZUELA AND COLOMBIA AND PANAMA, CUBA AND AMERICAN, DUTCH, FRENCH AND BRITISH WEST INDIA ISLAND POSSESSIONS, JULY TO DECEMBER, 1918

	Imports		Exports	
	*Kilograms	*Value	*Kilograms	*Value
Islands of Archipelago of Curacao:				
Aruba	8,324	Bs.5,470	215,925	Bs.55,977.10
Bonaire	86,738	13,758	304,479	65,256.50
Curacao	1,139,024,750	262,478	24,351,447,300	7,029,538.61
Barbados			1,829,242	256,940.30
Cuba	86,408	20,032.01	174,712	112,008
Colombia	484,449	618,998.73	634,046	465,455
Panama	254,250	286,001.15	17,580	26,670
Porto Rico	402,429,650	610,883.05		
Trinidad	150,126,850	166,524.52	12,374,140,800	5,503,545.62
Martinique	72,005	84,743	3,357,212,700	687,152.90
Santa Lucia			3,687,252	1,735,377
	2,683,755,250	Bs.2,068,888.46	46,947,036,800	Bs.17,037,907.03

* Kilogram equivalent to 2.2046 pounds. Venezuelan bolivar normally equivalent to 19.3 cents American gold.

TABLE II.—VESSEL CLEARANCES FROM CHIEF PORTS OF VENEZUELA BY SHIP REGISTRIES, JULY TO DECEMBER, 1918

	Vessels		Tonnages		Totals	
	Steamships	Sail	Steamers	Sail	Ships	Tons
American	60	7	81,078	1,659	67	82,737
Spanish	15	....	57,788	......	15	57,788
French	22	9	11,893	1,910	31	13,803
Dutch	17	106	9,404	5,859	123	15,263
English	44	10	53,090	696	54	53,786
Italian	4	....	22,772	......	4	22,772
Norwegian	7	....	9,582	......	7	9,582
Venezuelan	36	836	7,306	21,858	872	29,164
Totals	205	986	252,913	31,982	1,173	284,895

agrarian and mining activity as sugar, coffee, cocoa, cotton, corn, tobacco and sisal and ores, cement, coal and oil, with which latter the western areas of the republic are prolifically supplied, has necessitated the opening up of new seaboard gateways.

At Ocumare de la Costa the Venezuelan Ministry of Public Works has completed a modern dock, which will be equipped with the most approved type of discharging and loading apparatus, terminal railway facilities and warehouses and, too, will be the seat of an up-to-date *congelacion* with meat chilling, instead of meat freezing, mechanism to take better care of the great volume of live stock shipments on the hoof and by special cattle carrying motor equipment which it is planned to divert to the new port from the interior *llanos* through Maracay.

New Concrete Piers

The newly completed pier at Ocumare is one of the finest examples of concrete construction in the country. Its total length is 492 feet, its width 19 feet 8 inches and the height of the dock flooring above the sea level 7 feet 10 inches. The cost of the work amounted to $29,397.28, and much of the material for the pier was brought from the United States.

This pier affords a concrete illustration of the scale upon which dock construction and improvement is proceeding at the several ports of the country, among which may be mentioned in particular that of Cristobal Colon, a strategic point of vital importance on the Gulf of Paria, considerably to the seaward of the British Island of Trinidad. There, too, a large modern concrete dock is now in course of construction.

At Puerto Cabello there is situated the *Dique y Astillero Nacional* combined naval and military machine shops and dry docks, where in the last five years not only Venezuelan naval and other government craft but native mercantile and passenger vessels have been constructed and liners regularly plying in trans-Caribbean service between Venezuelan ports and the United States and Europe are accommodated for repairs. A familiar sight in the waters about Puerto Cabello is the Venezuelan gunboat *Mareschal Sucre* (named for the Venezuelan "Marshal of France," who achieved immortal fame in the Napoleonic wars). This vessel is the erstwhile *Dubuque,* a unit of the American Navy, converted for more restricted cruising patrol in the Caribbean and the Orinoco River and Delta.

Dock Construction at the Port of Cristobal Colon, Venezuela. Reinforced Concrete, With Native Cement, is a Leading Factor of Present-Day Building Operations in the Republic

"The Dique," as the big Puerto Cabello plant is popularly known, now boasts a good-sized steel dry dock and a smaller one of wood. The former was brought to its permanent location from Erie Basin, Brooklyn, in two sections a year or two ago. It is 282 feet in length, 110 feet outside width, 90 feet inside width and 18 feet maximum draft over the keel blocks, and has a maximum lifting capacity of 3,000 tons. The wooden dry dock is 180 feet long, 80 feet outside width, 60 feet inside width and a maximum draft over keel blocks of 17 feet. It has a maximum lifting capacity of 1,200 tons.

The plant includes a steel foundry of the first class, and is equipped for the construction and repair of ships and of boilers, engines and ships' machinery.

Newly Constructed Dock at Recently Opened Port of Ocumare de la Costa, Terminus of Spur from 1,800-Mile System of Modern Motor Highways

Marine Engineering

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WE GUARANTEE that of this issue 9,400 copies were printed; that of these 9,400 copies 7,531 were mailed to regular paid subscribers, 442 were provided for counter and news company sales, 408 were mailed to advertisers, 79 were mailed to employees and correspondents, and 920 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 99,050—an average of 9,905 copies a month.

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Annual Index to Be Published Separately

OWING to the shortage of paper, the annual index of MARINE ENGINEERING, which formerly was published as a part of the December issue, will hereafter be published separately at the end of the year. As the annual index will be useful only to those subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to fill the orders received for it at this office on or before December 1. A copy of the index will be mailed without cost to each subscriber whose order is received on or before that date.

Advance in Subscription Rates

WE have to announce to our readers at this time an increase in the subscription price of MARINE ENGINEERING. Hereafter the subscription rate throughout the United States, Canada and Mexico will be $4. The rate to subscribers in other countries will be $5, and the price of a single copy 35 cents.

Publishers, like everyone else in the business world, have been faced with tremendous increases in the cost of materials. For example, the cost of engravings used as illustrations in our editorial pages has gone up 265 percent. Other items have increased as much as 125 percent. In this connection it should be remembered that postage on second class matter was materially increased on July 1, 1920, and that it will be increased *again* on July 1, 1921. We could go into greater detail regarding these matters, but we feel that our readers appreciate the conditions, which are world-wide in scope.

We are planning bigger and better things for MARINE ENGINEERING and we are confident that we will continue to have your support in the future as we have had it in the past. Our aim is to make the magazine of the greatest possible value to its readers and we expect not only to keep all our present readers with us, but to go on steadily adding to our subscribers.

Technical Training in Naval Architecture

NOW that the United States is rebuilding her ancient prestige on the seas, it is interesting to consider what facilities there are for the technical training of experts on whom the qualities of future ships will largely depend. It is not too much to say that during the war the engineer came into his own. Now that the war is ended we find that all the colleges in the land are crowded, and in particular the engineering colleges. Thousands of young men are now laying the foundations for technical careers. If all the ships of the ocean could be assembled, they would make an immense fleet and represent billions of dollars. And yet all the ships, on all the seas, are but a fraction of the industrial contribution of the world, and all the shipyards, with all their workers, are relatively but a handful. And of the workers only a fraction are employed on scientific work.

Two of the leading educational establishments of the country offer fully equipped courses in naval architecture, namely, the Massachusetts Institute of Technology and the University of Michigan; there is also the Webb Academy, which has deservedly a high reputation though not of collegiate grade. For good or ill, the technical schools of the country are standardized; study one and you know all. They all teach pretty much the same thing in the same way; in fact, they cannot well do otherwise, if they are worthy to stand in the first rank. The catalogue of the Massachusetts Institute of Technology is fairly easy to understand because each department has not only all subjects of the curriculum set down, but also the hours both for school work and for home study. Let us see what we can learn about its course in naval architecture.

In the first place, we find that it has the eight-hour day; eight hours a day, six days in the week for the thirty weeks of each of the four school years. A student may have a lecture in theoretical naval architecture and another in ship construction and many have three hours in the drawing room; then he can go home and work three hours by himself. The curriculum for naval architecture is well balanced and well distributed, but there is an interest in seeing what would happen if the work could be bunched. A little simple arithmetic shows that something less than a school year is given to naval architecture and marine engineering, that two years and a half are given to subjects more or less common to all engineering courses, and that half a year is left for non-technical subjects like languages and literature. The last item may well receive careful consideration by those who remember that an engineer is a man with human interests; but we cannot dwell on it now.

Take the middle group of two years and a half. Of this, mathematics gets half a year and physics and chemistry nearly a third of a year each; general engineering gets something less than a year and a half. In general engineering are included drawing, machinery, heat engineering applied mechanics and electricity, with plenty of laboratory and shop work. All of our technical schools show a like condition, which is right and necessary, for our engineer must be an all-around man as well as a specialist.

Coming back to the course in naval architecture, we find that its year gives about one-fourth to marine engineering. A ship designer must know something about the engines, be they reciprocating steam engines, turbines or oil engines. That the practical side of naval architecture (ship construction and design) should have twice the attention that is given to theory looks right enough, even if we bear in mind that a man gets his theory in school and practices all the rest of his life. But it may be a little startling to find that all the theory is given in 5½ percent of the four years. If a man could work eight hours a day on dry theory he could clean up the whole thing in seven weeks.

Naval Architects and Marine Engineers

NAVAL architecture and marine engineering are one profession with two branches, just as medicine includes the physicians and surgeons. But every student of medicine receives training in both branches of his profession and every physician can do simple surgery at a pinch, and any surgeon would prescribe if a physician were not at hand.

In the beginning every shipbuilder was a carpenter and every engineer was a mill wright, and they divided their work according to the material. Anyone could then tell where the ship ended and the engine began. Now the case is not so clear. For a reciprocating engine the engine bed is of cast steel and the foundation is riveted up in shapes and plates; but, depending on the designer or designers, the combined structure may be nearly all bed or nearly all foundation.

The engineer naturally has furnished the propeller and usually designs it, though logically the naval architect who powers the ship should be able to control the propeller design. The introduction of intermediate gears between the propellers and the steam turbine, or perhaps between the propeller and the internal combustion engine, enables the naval architect and the engineer to cut loose. The naval architect can design his ship and adopt the best propeller, and the engineer can run his turbine or engine as he will; both may get the best efficiency.

When a ship like a destroyer is built for the highest speed, the design should be centralized in the hands of one man who should be the master of the whole profession of naval architecture and marine engineering. For a slow freighter it may be possible just to build a ship and go out into the market and buy a standard engine.

It is now convenient to have a hull department and an engineering department in a shipyard, and probably always will be. Since business will not tolerate inefficiency, there is always some one, be he president, general manager or what not, who sees to it that the departments gear up correctly.

In both American and British technical colleges the theory of shipbuilding is taught in a course of naval architecture and marine engineering (or including marine engineering), which is strong on naval architecture and gives so much marine engineering as may be. A logical arrangement would be to teach the elements of the entire profession to all students of shipbuilding and allow specialization in either naval architecture or marine engineering.

The American Society of Naval Architects

IT is reported that the American Society of Naval Architects and Marine Engineers contemplates changing its name and appearing hereafter as the American Society of Naval Architects. Incidentally, there will be the advantage of a briefer title, should the change be made, but the real reason is that the science and art of shipbuilding, including all branches and details, should be unified, and that the members of the profession should be conscious of their essential duty. Such a result, if it can be accomplished, is greatly to be desired.

There is considerable confusion in the popular mind concerning the designation of experts engaged in the science and art of shipbuilding; those conversant with the matter know that a naval architect designs ships and that marine engineers have to do with the engines; also that a naval constructor is a commissioned officer of the navy who designs and superintends the construction of naval vessels. When we had an engineering corps for the navy the naval engineer had to do with the engines of warships. Since the line officers of the navy, or certain of them, have taken over the duties of the engineering corps, the term naval engineer has a tendency to become obsolescent.

Now the greater part of marine engineers are seagoing engineers; the marine engineer par excellence is the designer of marine engines and is the running mate of the naval architect. Not infrequently he is versed in naval architecture. Consequently the chance of confusion from the use of the term marine engineer is unfortunate. There was a time when the naval architect had the same relation to the shipwright that the architect had to the house carpenter. The name naturally implies a similarity that no longer exists, and adds to the chance of popular confusion.

The several terms may be associated by the following form:

Naval architect
Naval constructor
Naval engineer
Marine engineer

If we make a permutation of the two first terms and the three last terms, there are six possible combinations, of which four are proper, leaving two that are improper, namely, marine architect and marine constructor. It is curious how often the first mistake is made even by intelligent, well-informed men who have a real interest in shipbuilding, although the term marine constructor seldom appears.

NEW BOOKS

Hot Bulb Oil Engines

REVIEWED BY C. H. PEABODY, DR. ENG.

Hot Bulb Oil Engines and Suitable Vessels. By Walter Pollock, M. I. N. A. Size, 6 by 8¾ inches. Pages, 430. Illustrations, 441. New York, 1920: D. Van Nostrand Company. Price, $10.

There are two main classes of internal combustion engines: (1) those using a fuel which, like gasoline, can be vaporized in a carburetor, and (2) those that use oils that must be sprayed into the cylinder and largely, if not entirely, burned in the fluid condition. In America, gasoline motors found ready favor and were but little restricted, but in England both the Admiralty and the Board of Trade disliked gasoline and attention was directed to heavier oils, which are less dangerous and also less expensive. The pioneer work up to 1890 was done by the Priestman and the Hornsby-Akroyd engine companies; they used oils heavier than gasoline, which were vaporized in a separate chamber before entering the cylinder. This hot chamber has been standardized as a hot bulb into which the oil is sprayed at or near the end of the compression stroke and where it is partially vaporized and partially burned as finely divided fluid. This process is likely to crack some of the oil and the carbon is liable to form a hard, adhering incrustation. Provision must be made for removing this carbon at intervals. Starting a little later, but paralleling the development of the hot bulb engine, the Diesel engine by its superior economy of fuel has received favor for use on large vessels, but has not been put on the market in small sizes. The hot bulb engine can be had in all sizes and its less weight and cost, together with the advantage of easier management, has led to its wide adoption, especially in Europe. It deserves more favor than has been accorded it in America, and the present volume is well calculated to work toward that end, as it covers the field well, is excellently illustrated and is not too technical.

Though started in England, the best development of the hot bulb engine has been in Sweden, but it is made in nearly all industrial countries, i. e., Denmark, Norway, Holland, France and America, where it has had to struggle against the gasoline engine already well established. Germany gave most all attention to the Diesel engine.

Like all internal combustion engines, except the Diesel, the hot bulb engine is made to work on the two-stroke cycle or the four-stroke cycle, and like all such engines the four-stroke engine meets with the most favor.

The author illustrates thirty-six makes of hot bulb engines from all the seven countries named, from which may be had a good idea of the essential features of the engine and the various ways of fulfilling the necessary conditions. He gives special attention to forms applicable to marine propulsion and to the larger sizes for that purpose. He quotes the development of 150 horsepower per cylinder in practice and thinks that 250 can readily be obtained; this latter power per cylinder can be applied to the bulk of freighters provided twin screws and multiple cylinders are used as in Diesel practice.

A marine engine of whatever power must be reversible. Trivial boats may use reversible propellers, moderate powers may be reversed with gearings, but large engines must be reversed directly. Two-stroke engines can all be reversed by pre-ignition. This is familiar enough for small engines, but it may not be generally known that it is applied for all sizes and is customary with the Swedish Bolinder engine. The engine is slowed by diminishing and then interrupting the oil supply and is usually unclutched. Oil is injected before the piston reaches the top of the stroke, whereupon the engine reverses and the clutch may be thrown in. The Bolinder engine has been thoroughly tested by reversing without unclutching. Large four-stroke engines are commonly reversed with compressed air and the gear for that purpose has some complication. It is claimed that an oil engine can reverse quicker than a steam engine.

The essential feature of this type of engine is the hot bulb, to which the author gives special attention. In all cases the bulb must be heated by a special lamp before starting. It remains hot during action at full power, but must be either heated or provided with some special device when the engine is running light. It is best made of cast iron and may last several years. A variety of forms and devices are shown. Closely connected with the bulb and essential to its action is the apparatus for fuel injection, including the fuel pump and the governor, which acts directly on the fuel supply. Some engines for vessels have gear for regulating the fuel supply carried up to the deck. In general, the engine, whether stationary or marine, is started without load and has a clutch which may or may not be associated with a reversing gear. Small engines can be started by swinging the flywheel, throwing into action a starting cam, which reduces the compression, as is common with all internal combustion engines. Large engines should have some form of power starting gear. Compressed air is the best form and may, of course, be used also for reversing.

The author's treatment of propellers is superficial, as it must be in a book covering so wide a range. It is judicious except as he gives a simple diagram for determining dimensions of propellers, a matter that cannot be dealt with so simply. He is right in urging standardization of engines and propellers. The ships should be standardized at the same time.

The author has a chapter on the financial advantage of oil engined ships over steamships using coal; he properly considers that when an oil engine can be used the combination of oil and steam is a half-hearted compromise. On large ships for passenger service or war he concedes the necessity of using steam (probably in turbines) for some time. He gives an example of relative costs of power for a certain ship with (1) a hot bulb engine, (2) a steam engine and oil burned under the boiler, and (3) a steam engine with coal. It is not unlikely that something like the advantage he claims for the hot bulb engine can commonly be obtained, but any such comparison is likely to change in a marked manner with change of time and place, and the present is a most uncertain time.

A long chapter is given on the application of hot bulb engines to all sorts of craft, mostly of small or moderate size, though he mentions an American tanker carrying 5,000 tons and having three sets of engines of 500 brake horsepower each. In his list are small freighters, coasters, tugs, lighters, trawlers, dredgers, lifeboats, tropical and arctic vessels and all sorts of yachts and houseboats. If any criticism of his illustrations is proper, we may question the advantage of showing so many examples, many of which are similar.

The author is of the opinion that an engineer who really knows his hot bulb oil engine will agree that it is the simplest engine he has ever seen and he would never think of going back to steam. Also he thinks that engineers can be more easily and quickly trained than for any other engine. From the simplicity of the engine few troubles are to be anticipated, though he admits that troubles will occur. Directions are given for preparations for starting and stopping, and for running, including maneuvering and running lights. A useful table gives the periods after which certain parts of the engine should be opened, cleaned and inspected, ranging from one month for fuel filters to a year for cylinder jackets and fuel pumps. Hints are given concerning the installation of engines and accessories; they are intended rather for the engineer of the ship than the designer, though the latter may find an advantage from looking at things from the engine driver's point of view.

Auxiliary machinery for hot bulb engines has not received the attention deserved, and the final chapter of this book on that subject is therefore the more important. The author names nine classes of such machinery, all but two being imperative on ships of a thousand tons, i. e., steering gear, cargo winches, windlasses, electric lights, wireless, bilge pumps, ballast pumps, discharge pumps for tankers, and compressed air. He sets aside the steam donkey boiler as undesirable on an oil-engined ship, and discusses three ways of dealing with auxiliary machinery: (1) separate oil engine, (2) electric generator sets, (3) connection with the main engine by connecting rod, belt, chain or gearing. If an air compressor is found on a ship it may be taken as the source of power for some of the machinery, especially as the customary deck gear and pumps need little alteration for using air instead of steam. Steam is well adapted to working windlasses and winches, as they can be designed to stall under excessive load without breaking the lines. Of course, compressed air has the same property. Now that electric drives for auxiliary machinery are becoming standardized, a designer may well decide to install a sufficient hot bulb electric plant and use it for working all the auxiliaries. Some auxiliaries may advantageously have their own engines. Connection by any means to the main engine is of doubtful advantage to auxiliary machinery; perhaps an exception can be made for bilge pumps either regular or emergency. The hot bulb engine appears to be well adapted to auxiliary machinery for sailing vessels, in place of the gasoline engines that have long been in use on our coast.

Old=Time Ships of Salem

Old-Time Ships of Salem. By Robert S. Rantoul and William O. Chapman. Size, 9 by 11 inches. Pages, 70. Illustrations, 16 colored, 19 black and white. Essex Institute, Salem, Mass. Price, $3.

To those who are interested in the start of things as well as their development to their present stage, this unique publication will prove a treasure. It tells graphically and with the force of brevity how the hardy mariners of the late 1700's and early 1800's took their full-rigged ships of less than 100 feet in length, and often less than 300 tons burden, on cruises to the uttermost reaches of the globe, taking as a matter of course labors and dangers which would be regarded as hair-raising "stunts" in these days when a 12,000-ton ship, propelled by steam and electricity, is nothing to excite comment.

And they brought back to the "Wild New England Shore" freights which laid the foundation of more than one of the down east fortunes of the present, as well as giving good returns to the men who manned them, most of whom had an interest in the ventures, however small.

The little book is crowded with stirring narratives of the old days, the authors were well acquainted with their subject, and the Essex Institute is to be congratulated on having published a work which is historically, typographically and pictorially a thing to be treasured.

The Dreadnought

The Dreadnought of Newburyport, Massachusetts. By Francis B. C. Bradlee. Size, 6½ by 9 inches. Pages, 28. Illustrations, 7. Salem, Mass., 1920: The Essex Institute. Price, $1.

Perhaps the most famous of the Liverpool packet ships, which made maritime history in the days before steam and the Civil War put them out of business, was the *Dreadnought*, which, built in Newburyport by Currier & Townsend in 1853, made, under command of her equally celebrated skipper, Captain Samuel Samuels, the record voyage of 9 days and seventeen hours from Sandy Hook to where she was taken up by a Queenstown pilot. This little brochure is a valuable addition to the lore of the days when "a wet sheet and a flowing sea" were the ideal conditions for making speed, as in addition to the story of the *Dreadnought's* exploits there are sketches of other ships of her time which add to its interest.

It is neatly printed, with a heavy paper cover of dark blue, and one page is given over to the *"Dreadnought"* chantey, which has a prominent place in the songs of the sea that are now seldom used and are almost forgotten except by the oldest of "old salts."

Steamship Coefficients

REVIEWED BY C. H. PEABODY, DR. ENG.

Steamship Coefficients, Speeds and Powers. Charles F. A. Fyfe, M. I. N. A. Size, 4 by 6 inches. Pages, 399. Plates, 68. Tables, 45. London, 1920: E. & F. N. Spon, Limited. Price, $7.50.

In this compact volume the author has brought together and arranged for use all the information extant bearing on the important matter of speed and power of steamships, matter which is scattered through half a century of scientific publications and in the proceedings of learned societies, and in particular the societies of engineers and shipbuilders of Great Britain and America. All of this is assembled by the aid of the theory of mechanical similitude, and examples are worked out in detail. For convenience of the computor, tables of integral, fractional and mixed powers of numbers are given, and also extension tables, from which the computor may select or interpolate results instead of making special computations.

The author presents with considerable detail the results of experiments in towing tanks as given by the Froudes, by Admiral Taylor, Colonel Rota, Mr. G. S. Baker and Professor H. C. Sadler and Mr. W. J. Luke. He states the methods of presenting results used by the Froudes, but prefers Admiral Taylor's method of giving the residual resistance in pounds per ton displacement. He gives reproductions of Froude's diagrams for propellers and applies them to numerous problems for finding dimensions and proportions.

Nearly half of the book is devoted to tabulating miscellaneous data gathered from all sorts of sources, and this part of the book gives evidence of extreme haste, throwing together results of trials of ships in detail, assembled tables of coefficients from various ships, statements of evidence and opinions on mechanical efficiency of engines, thrust block friction, resistance of bilge keels and other appendages and the like. Unfortunately, the index is incomplete, so that information is difficult of location.

Correction.—In the letter on "Method of Estimating Steel Hull Weights" published on page 774 of the September issue, a typographical error occurs in the last line of the next to the last paragraph, where the coefficient should be .30 instead of .03 as printed.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Rules for Fuel Oil Piping

Q. (1101).—Will you please let me know what are the rules for fuel oil piping, according to the requirements of the United States Supervising Inspectors and Lloyd's Register. I understand that according to United States rules if oil is carried above the tank top, gate valves should be fitted inside the tank and operated from deck; also steam valves for trimming pump and service pumps to be operated from deck, but I am not able to find a written rule for it. M. V.

A. (1101).—The recognized classification societies do not lay down detailed specifications for fuel oil piping systems, but rather fix certain basic principles and require the submission of the piping layouts developed in the individual case for approval. The United States Steamboat Inspection Rules cover the matter in the same way. Thus it is apparent that the details become to a certain extent matters of judgment with the inspectors, modified by the recognized practice in a given locality.

Model Experiments in Running Stream of Water

Q. (1103).—I shall appreciate it highly if you will kindly inform me what has been done experimentally, or otherwise, in the way of making model experiments in a running stream of water, instead of the usual "tank" experiments relating to "towline pull," etc. It appears to me that a model could be suitably mounted in a trough of rectangular or semicircular section, through which water could be flowed by means of a centrifugal or propeller type of cheap pump (passing suitable guides, of course, before coming into contact with the ship to give practically straight stream lines), from which many useful measurements and much useful data could be obtained, at a fraction of the capital investment for apparatus and housing that the usual "naval testing tanks" cost. No doubt this matter has been considered, and possibly tried, but I do not remember seeing descriptions or articles upon this subject, and so shall be pleased to hear where I can find such. Possibly you have published such. F. W. S.

A. (1103).—The flow of water past a fixed object or model has been utilized in England, Germany and the United States for the investigation of problems of resistance and propulsion. After a certain amount of experimentation, this method of investigation was discontinued in this country in favor of the usual or still water method. Information relative to the German work along this line is not available.

The British national experimental tank, placed in service in 1910, has as part of the equipment a small tank having a breadth of 5 feet and a depth of 3⅛ feet throughout its uniform section. The length of uniform section is 31½ feet. The tank is built of reinforced concrete and is intended for use either with still water and moving model or with flowing water and fixed model. In the latter condition it is supplied by a 2½-foot rotary pump capable of delivering 75 cubic feet per second and designed to give a water velocity of 3 miles per hour. An 80-horsepower motor is used to drive this pump. Provision is made for maintaining the water at a constant temperature.

"This small tank is intended for general laboratory experiments and for more or less exploratory work with models."—(From paper by G. S. Baker, referred to below.)

The practicability of any experimental tank depends largely upon the facilities which it affords for the carrying out of the various investigations desired. Among the usual investigations may be mentioned the following:

(1) The resistance of ship forms.
(2) The resistance of ship appendages.
(3) The efficiencies of ship propellers.
(4) The effect of waves on the resistance of ship forms.
(5) The rolling of ships among waves.
(6) The effect of shallow draft upon the resistance of ship forms.
(7) The erosive effect of propeller action upon the beds of shallow channels.

It is evident that for purposes (1), (2) and (3) either still or flowing water could be used satisfactorily under proper circumstances. For (4) and (6) the still water method appears to have advantages, and for (5) and (7) it would seem difficult to adapt the flowing water at all.

There are also certain difficulties in connection with the flowing water method which would have to be overcome in order to make it of general use. Principal among these may be mentioned the following:

The great size of pump and motor required to secure a satisfactory flow of water at a speed of 6 or 7 miles per hour through a tank having a width of, say, 30 feet and a depth of water of 12 feet (such dimensions and speeds have been found to give satisfaction with the sizes of model which appear necessary in order to secure accurate results).

The floor space required for such an installation.

The difficulty in so baffling and deflecting as to secure water of uniform speed throughout its mass when approaching the portion of the tank in which the model is fixed.

Information in some detail relative to the small British tank referred to above may be obtained by consulting papers read by Mr. G. S. Baker before the Institution of Naval Architects, April 5, 1911, and March 29, 1912.

A description of our own model tank and the methods employed there may be found in "Naval Construction," by R. H. M. Robinson.

Stern Anchors

Q. (1104).—We should be much obliged if you can give us some information with regard to vessels having a windlass on the poop aft and anchors in hawse pipes at the stern. We understand that this arrangement is sometimes provided and are anxious to get particulars of same.

A. (1104).—This question, as stated, is very definite, making inquiry relative to stern anchors (plural). Replying to it on the basis of its exact wording it may be said that comparatively few instances of the fitting of more than one stern anchor have been noted by the writer.

If it is assumed that the inquiry covers installations of single stern anchors also, it is suggested that the party be referred to:

(1) The Federal Shipbuilding Company, Kearney, N. J. The general plans of the 9,650-ton deadweight general cargo vessel prepared by this company show a stern anchor in hawse pipe and apparently handled by a wildcat fitted on the gypsy shaft of the after winch.

(2) The Bethlehem Shipbuilding Corporation, South

Bethlehem, Pa. The general plans of a 12,000-ton deadweight tanker built by this firm show anchors stowed aft on the upper deck. In this case, however, hawse pipes are not provided. The anchors are probably handled by a cargo boom.

The general plans of the Hog Island type-B ship show such an anchor and hawse pipe, but do not give the detail desired.

Interpreting the question still more broadly, it may be stated that there is no clearly defined practice relative to the use of stern anchors. The Germans have used them in many of their large naval vessels. On these ships a single anchor carried in a hawse pipe well aft, either at the side or on the centerline, has frequently been fitted. The British have followed a similar practice in such vessels as the *Eagle* and *Argus, Furious, Courageous* and *Glorious,* as well as in some light cruisers and monitors. Most of the capital ships in the United States Navy carry small stern anchors weighing 5,000 or 6,000 pounds. They are not, however, carried in hawse pipes, but are stowed on deck and handled by means of crane or davit. In some of the United States gunboats, stern anchors are carried stowed on chocks on the weather deck aft. In such cases a collapsible anchor crane has frequently been fitted, so located as to plumb the stowage position, and of such outreach as to swing the anchor well clear of the vessel's side.

Pressures at Various Compressions of a Spring

Q. (1106).—Please give formula and calculation for the pressures at various compressions of a spring; that is, at what pressure will a safety valve spring release at various points of compression? Assume a spring made of 3/8-inch round steel; inside diameter, 1 1/16 inches; outside diameter, 1 13/16 inches; height of spring not under tension, 6½ inches; number of coils, 12. At what pressures will it release by ¼-inch compression? A. O. M.

A. (1106).—The pressure required to produce any given deflection in a cylindrical helical round bar spring is expressed by the following formula:

$$P = \frac{fTd^4}{8D^3n},$$

where

- P = pressure in pounds.
- f = deflection in inches.
- T = torsional modulus of elasticity in pounds per square inch.
- d = diameter of wire of spring in inches.
- D = mean diameter of coil in inches.
- n = number of coils.

The deflection of the spring in the above problem will depend upon the value used for T, which is variously given from 10,000,000 to 14,000,000 pounds per square inch. Assuming a value of 12,600,000 pounds per square inch, as given by "Machinery" for steel, then, since D = 1 1/16 inches + 3/8 inch = 1 7/16 inches,

$$P = \frac{\tfrac{1}{4} \times 12{,}600{,}000 \times (\tfrac{3}{8})^4}{8 \times (1\ 7/16)^3 \times 12} = \frac{12{,}600{,}000 \times (3)^4 \times (16)^3}{4 \times 8 \times (23)^3 \times (8)^4 \times 12} =$$

218.44 pounds.

It will be observed from the formula that for a given spring T, d, D and n are constants. P, therefore, varies directly as f; hence, P equals a constant times f and may be written $P = cf$, where $c = \frac{Td^4}{8D^3n}$ and $QP = Qcf$, where Q is any factor, either integral or fractional. Hence for any other deflection than ¼ inch, as $Q \times$ ¼, the required pressure to produce that deflection will be $Q \times$ 218.44.

It will also be noted that neither the free height nor the solid height of the spring appears in this formula. If, now, we let h equal the solid height of the spring, i. e., the height when all the coils are compressed together, then

$$h = nd \text{ and } n = \frac{h}{d}.$$

Substituting this value of n in the formula gives $P = \frac{fTd^5}{8D^3h}$. This formula, with a change in notation, and all other formulae usually used in practice for cylindrical helical round bar springs are tabulated on pages 415 and 416 of "Machinery's Handbook," fifth edition (1915).

The derivation of helical spring formulae is given in various higher class text books, among which "The Strength of Materials," chapter XII, by Ewart S. Andrews, B.Sc.Eng., and "The Elements of Mechanics of Materials," chapter IV, by C. E. Houghton, AB., M.M.E., are especially recommended.

Feeding Boiler by Injector

Q. (1100).—In a tug of about 200 indicated horsepower, the feed pump broke down and it was necessary to feed the boiler by an injector which could just do the work, taking the water from the jet condenser at the usual temperature. It was now, however, impossible to maintain the full steam pressure even by hard working. I should like to know the cause of this, as all of the heat with an injector returns to the boiler and I cannot assume that the losses by shock and friction in the injector are so considerable. D. K.

A. (1100).—The difficulty experienced in trying to maintain the original boiler pressure while feeding by means of the injector is due to the extremely low efficiency of the injector when judged simply as a pumping device. The steam consumption in the case of the injector may be considered as roughly four times that required by the ordinary feed pump when furnishing the same amount of feed water as the injector. A partial explanation of this difference lies in the fact that, while the injector is subject to but very small heat losses, its operation involves the imparting of the energy stored in a relatively large steam supply, in the form first of high velocity and then of pressure, to a small jet of water. During the process the steam supplied is condensed and returned to the boiler as water, where it must be transformed again to steam. The low efficiency of the direct acting pump ordinarily used for boiler feed purposes becomes negligible if the exhaust steam is all applied to heating the feed water.

For further information on this and related subjects, your attention is invited to "Practical Marine Engineering," by C. W. Dyson (7th edition), pages 443 to 448 inclusive, also to "Mechanical Engineer's Pocket Book," by Kent, under the subjects of "The Injector," "Boiler-feeding Pumps," etc.

Evaporation of Lubricating Oil

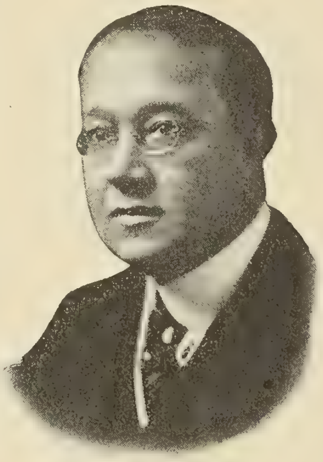
Q. (1051).—I should like to know the amount of evaporation which would occur when 1,500 gallons of lubricating oil are heated to 180 degrees F. for 24 hours. The grade of oil is Vacuum oil D. T. E. extra heavy, 25.3 degrees Baumé, .905 specific gravity, 7.509 pounds per gallon. J. H. A.

A. (1051).—Unfortunately the maximum evaporation loss is not often stated in lubricating oil specifications, although for transformer oils it is important. A certain mineral lubricating oil of .88 specific gravity lost .06 percent of its weight when heated to 212 degrees F. for five hours. At lower temperatures the loss would be considerably less, also the evaporation loss per hour decreases the longer it is heated. In a turbine gear casing the conditions are likely to be different from a watch glass containing oil and placed in an oven. The leakage loss is probably more than the loss by evaporation in a gear casing.

PERSONAL MENTION

William Chisholm is to succeed A. J. Frey as head of the Construction and Repair Division of the Shipping Board on the Pacific Coast. Mr. Frey has retired from the Board to accept a position with a private company.

William H. McGee, of William H. McGee & Company, New York City, has been named national councillor of the National Board of Marine Underwriters to represent this organization in the Chamber of Commerce of the United States. For some time past Mr. McGee has held this position in the Chamber of Commerce, which is made up of representatives from more than 1,300 commercial and industrial organizations. The function of the council of the Chamber on which Mr. McGee will serve is to determine the programme and appoint nominating committees for the annual convention. Each councillor also acts as chairman for the members of the delegation representing his particular organization.


William H. McGee

J. W. Linck, assistant to Robert L. Hague, former chief of the Division of Construction and Repair of the Shipping Board, is now with Victor S. Fox & Company.

Charles Whiting Baker has recently announced his retirement from engineering journalism, in which field he has been connected with the *Engineering News-Record* since 1886. Under his direction the Engineering Business Exchange, 30 Church street, New York, has been organized for the purpose of bringing together those desiring to sell or purchase engineering or technical business properties. Mr. Baker graduated from the University of Vermont in 1886, in which year he became associate editor of the *Engineering News*. At various periods since that time he has been editor-in-chief and consulting editor of the journal and vice-president and director of the Engineering News Publishing Company. He is a member of the American Society of Mechanical Engineers and at the present time vice-president of the American Society of Terminal Engineers. Since 1915 he has been a member of the Engineers' Club, New York City, and since 1917 a member of the Engineering Council, representing the American Society of Mechanical Engineers. He has also been prominent in public affairs.

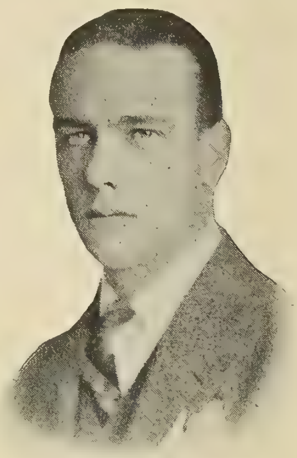

Charles Whiting Baker

Captain M. S. Harloe, formerly a lieutenant-commander in the United States Navy in command of a naval transport, has been appointed agent of the United States Shipping Board division of operations in Japan.

C. D. Kennedy, district agent for the Division of Operations of the Shipping Board, Portland, Ore., has resigned to take the position of Portland agent for Norton, Lilly & Company.

Lieutenant-Commander William L. Vale Dayo, U. S. N., has recently been appointed aide to Rear Admiral Samuel Robison, commandant of the Charlestown Navy Yard, Charlestown, Mass. He was formerly in command of the destroyer *Morris*.

G. Bronson Philhower, Jr., is now with the Reading Iron Company, Reading, Pa., in its New York sales department. Mr. Philhower has had extensive training in related fields—the technical publishing business in New York, automobile and tool steel sales work, and, during the war, the mechanical division of the Navy, Mr. Philhower being attached to the aviation and submarine chaser divisions. His sales experience has been supplemented by an intensive course of training in the various plants of the Reading Iron Company, whose apprentice course Mr. Philhower entered in February, 1920. After having worked in various capacities and gained a detailed knowledge of the manufacture of wrought iron pipe, Mr. Philhower was appointed salesman, with headquarters at the Reading Iron Company's New York office, 99 John street.


G. Bronson Philhower, Jr.

H. A. Noble, vice-president of the Pittsburgh Spring & Steel Company, Pittsburgh, Pa., has been elected president to succeed D. C. Noble who died recently. S. F. Krouth, secretary and assistant treasurer has been elected vice-president and treasurer, with headquarters at Pittsburgh. J. N. Brownrigg, eastern sales agent in New York, has been elected vice-president and eastern representative, and F. Ryan, western sales agent at Chicago, has been elected vice-president and western representative, with headquarters in Chicago.

Martin J. Gillen recently announced his resignation as a member of the Board of Trustees of the Shipping Board Emergency Fleet Corporation and as special assistant to the chairman. In his work with the Shipping Board as assistant to Chairman Payne and later to Chairman Benson, Mr. Gillen gave most of his attention to the settling of claims growing out of the cancellation of war contracts. It is reported that Mr. Gillen will succeed Swager Sherley as director of finance with the Railroad Administration under Director General John Barton Payne.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

PRESIDENT NULLIFIES SECTION 34 OF MERCHANT MARINE ACT

Declares Congress Encroached On His Prerogatives and Exceeded Its Powers In Ordering Abrogation of Classes In Commercial Treaties

Official announcement was made on September 24 by Secretary of State Colby that President Wilson had decided not to give notice of the abrogation of certain clauses of commercial treaties as provided in the new Merchant Marine Act.

The Act directed the President to give notice within 90 days after the passage of the Act that the treaties in question would be terminated. More than twenty nations were affected and numerous protests already have been made by some of them. The 90 days expired on September 4.

Secretary of State Colby in making the announcement made it clear that the President's decision with reference to the instruction given in Section 34 had no bearing upon other provisions in the Merchant Marine Act. The other parts of the law remain in effect, and the President in the near future plans to appoint members of the Shipping Board provided by the Act.

The formal statement issued by the State Department announcing the President's stand follows:

"The Department of State has been informed by the President that he does not deem the direction, contained in Section 34 of the so-called Merchant Marine Act, an exercise of any constitutional power possessed by Congress.

"Under the provisions of the section referred to, the President was directed within 90 days after the Act became law, to notify the several governments, with whom the United States had entered into commercial treaties, that this country elected to terminate so much of said treaties as restricted the right of the United States to impose discriminating customs duties on imports and discriminatory tonnage duties, according as the carrier vessels were domestic or foreign, quite regardless of the fact that these restrictions are mutual, operating equally on the other governments which are parties to the treaties, and quite regardless also of the further fact that the treaties contain no provisions for their termination in the manner contemplated by Congress.

"The President therefore considers it misleading to speak of the 'termination' of the restrictive clauses of such treaties. The action sought to be imposed upon the Executive would amount to nothing less than the breach or violation of said treaties, which are 32 in number, and cover every point of contact and mutual dependence which constitute the modern relations between friendly States. Such a course would be wholly irreconcilable with the historical respect which the United States has shown for its international engagements and would falsify every profession of our belief in the binding force and the reciprocal obligation of treaties in general."

Secretary Colby, commenting on the point made by the President that Congress had exceeded its powers, called attention to the veto by President Hayes of an act passed by Congress in 1879, which required the President to give notice to China of the abrogation of Articles V and VI of the Burlingame treaty. President Hayes declared that "the power of making new treaties or of modifying existing treaties is not lodged by the Constitution in Congress, but in the President, by and with the advice and consent of the Senate, as shown by the concurrence of two-thirds of that body."

Continuing his statement, Secretary Colby says:

"The Merchant Shipping Act was approved June 5, in the final rush of the session's close, with no opportunity to suggest, much less secure its revision in any particular. To have vetoed the Act would have sacrificed the great number of sound and enlightened provisions which it undoubtedly contains. Furthermore, the fact that one section of the law involves elements of illegality rendering the section inoperative need not affect the validity and operation of the Act as a whole."

The action of the President follows protests against the Jones law by twenty-two distinct nations, all of whose interests are seriously affected by it. England, France, Norway, Sweden and Denmark made the most violent protests.

It has been pointed out in shipping circles that, coming at a time when the interests of Great Britain and Japan are effecting a combination for a marine war upon the United States, and Norway, Sweden and Denmark are planning to impose discriminatory rates against American ships, the President's decision robs the Shipping Board of all its powers of retaliation and even of defense.

NEW ENGINE SAVES OIL

Bethlehem's Two-Cycle Marine Diesel Stands Sea Test

Charles M. Schwab, chairman of the Bethlehem Steel Corporation, gives credit to Arthur West, designer for the Bethlehem Shipbuilding Corporation, Ltd., for having perfected a marine Diesel engine which, with one-half the number of cycles in use on the present type of engine, can be operated with one-third the amount of oil generally used by ships with oil-burning steam machinery.

Mr. Schwab says the new engine is as far ahead of the present oil burners as the oil-burning ships are superior to coal-fired vessels, and that the new engine can be used on vessels of any size. Mr. Schwab, in his announcement, says:

"It is a great pleasure for me to announce that the Bethlehem Steel Corporation and the Bethlehem Shipbuilding Corporation, Ltd., have perfected a new two-cycle fuel-saving marine Diesel engine especially designed for American operating conditions, and adapted to land use as well as cargo vessels of any size. In the science and practice of marine engineering, this new engine represents a far greater advance over the oil-burning steamship than the latter is over the coal-fired steamship. It is also regarded as a signal triumph for American engineering skill in a field hitherto dominated entirely by Europeans.

"The development of the new Bethlehem fuel-saving Diesel engine represents two distinctive phases of advance in marine engineering.

"1 For the first time an internal combustion heavy oil engine for either marine or land uses has been perfected, which is not only designed and built by Americans but is built especially for Americans, and is adapted to American operating conditions.

"2. For the first time a two-cycle internal combustion heavy oil engine has been perfected which produces the same horsepower as a four-cycle engine practically twice its size, and is at the same time adapted to large cargo ships, while saving two-thirds in fuel cost alone, as compared with steam-driven oil-fired vessels.

"Neither of these developments is theoretically a new idea. For years Europeans have successfully operated large ships with Diesel engines. The achievement of Arthur West, the Bethlehem designer, who is at the head of our power department, is in the adaptation of the two-cycle engine to American operation and in its perfection for practical use in cargo vessels of any size.

"The success of this engine has already been demonstrated in two ways. It was installed and operated for ten months as part of the power plant of the Bethlehem Steel Corporation at Bethlehem, Pa. It was then installed in our new ore-carrying vessel, the *Cubore*, which has completed on regular schedule time, without a hitch, its first trip to Cuba."

FORTY-SEVEN CONSPIRACY CHARGES

Steamship Lines and Freight Brokers Indicted

Charged with being parties to a conspiracy in restraint of trade, in violation of the Sherman Anti-Trust Law, 38 steamship lines, 12 officers of the lines, 4 freight brokerage corporations, and 5 individual freight brokers were named in an indictment handed up to Judge William B. Sheppard in the United States District Court for the Southern District of New York on August 30 by District Attorney Francis G. Caffey.

The indictment, consisting of two counts, alleges a conspiracy between the freight brokers and steamship lines to keep all the freight brokerage business in the hands of the Steamship Freight Brokers' Association. It was alleged that 75 freight brokers, members of the association, handled 80 percent of the freight to or through the port of New York.

Pleas of not guilty were entered and bonds were given for appearance when summoned for a hearing.

177 Vessels Numbered in August

Eugene T. Chamberlain, Commissioner of Navigation, reports that 177 steam, sailing, gas and unrigged vessels of a total of 257,765 gross tons were built in the United States and officially numbered during August, 1920. Of these vessels, 67 of 257,738 gross tons, were metal craft, 48 of these, of 231,864 gross tons, being steamers.

Largest of the ships documented during the month was the *Golden State*, a passenger and cargo liner of 14,300 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the Shipping Board. Altogether 40 steamships, of more than 3,000 gross tons, are contained in the August enumeration.

During the month 27 vessels, of a gross tonnage of 22,248, were sold to British, Norwegian, Spanish and other foreign flags.

RAYMOND DEFENDS JONES

Answers Attacks on Marine Act Through Politics—Senator Renominated

H. H. Raymond, president of the American Steamship Owners' Association, 17 Battery Place, New York, came out early in the month with a strong reply to malicious political attacks on Senator Wesley L. Jones, the author of the Merchant Marine Act, declaring that attempts to undermine the Senator through foreign interference in American politics must be discredited.

That the attacks on the Senator were of no avail is shown by his renomination for a third term as United States Senator from the State of Washington by an overwhelming majority over his opponent, who was credited with having all the support Canadian and Japanese influence could bring to bear. President Raymond's statement follows:

"The rumor current in shipping circles here that foreign interests have raised a fund which is being devoted to the spreading of propaganda against Senator Wesley L. Jones and to an attempt to undermine him with the people is no surprise to me.

"The accomplishment of Senator Jones in securing the enactment of the Merchant Marine Act of 1920 is the greatest legislative step in behalf of an American merchant marine that has been taken in the past century. This legislation enables us to meet, if we wish, the handicaps which have been imposed upon us by similar legislation or by orders in council in other countries.

"Naturally shipping is a matter of international competition, and some of our foreign competitors are going to leave no stone unturned to defeat the objects of a measure so purely American. To seek to discredit a man who wields the influence of Senator Jones in shipping affairs would be a logical step in such a programme.

"Some foreign governments do not want to see us have a mercantile marine. So far as foreign trade is concerned they have had their wish in this respect for more than fifty years past. The American flag has been a rare sight in foreign ports. We have depended almost solely upon the vessels of other nations for the carrying of our shipping in foreign trade. When the war started in 1914 the United States was carrying but 10 percent of its own foreign commerce.

"Countries upon which this country had depended for transoceanic transportation became engaged as belligerents in the World War. Their vessels limited their cargoes to commodities essential to the prosecution of the war. There was an unusual demand for the products of all character of our manufactories, but our people could not avail themselves of this business because we had not the vessels in which to transport merchandise other than that specified by the governments of the belligerent countries. The period I refer to is previous to our own entrance into the war, of course.

"When in 1917 we did enter the war it became necessary for us to construct speedily a merchant marine. Without one we were almost helpless. Then we paid directly in dollars a part of the penalty for our having depended theretofore upon the merchant vessels of Germany, England, Japan and other countries.

"The United States has the vessels now and has an opportunity to develop and maintain an efficient American merchant marine, sufficient to handle our fair share of the world's carrying trade in foreign commerce and adequate for our needs as a naval auxiliary in time of emergency. The most far-reaching step in behalf of the permanency of such a fleet is the act for which Senator Jones is so largely responsible. We should see to it that foreign interests are prevented from discrediting this great piece of legislation and undermining Senator Jones, who stands out boldly for American shipping."

Twenty-Six Ships Delivered in August

The Shipping Board received from American and Japanese builders 26 steel ships during August, aggregating 219,075 deadweight tons, according to official government figures. The *Eastern Leader* and *Eastern Temple* were the Japanese contributions to the list. Only two of the 26 vessels were under 5,000 tons, while the majority ranged between 8,000 and 9,000 tons.

Perhaps the most significant event of the month was the delivery of the first combination passenger and freight liner out of 23 now building for the Government. The *Panhandle State*, a 13,000-ton steamer, was completed on August 30. The Hog Island fabricated steel plant finished the United States Army transport *Cantigny* and delivered her to the army authorities.

Fifteen steel steamers were launched by American shipyards for the Shipping Board—the largest being the 13,000-ton combination freight and passenger liner *Empire State*, by the New York Shipbuilding Corporation. The Kiangnan Dock & Engineering Company, at Hong Kong, sent the 10,000 deadweight ton oil-burning freighter *Celestial* down the ways, while the Moore Shipbuilding Company, at Oakland, launched the 10,000-ton oil tanker *Stockton*.

Cargo Ships and Tugs Sold

Sale of four vessels for a total of approximately $6,800,000 has been announced by the Shipping Board. Three tugs have also been sold for $80,000 each. The cargo vessels included ships assigned during the summer to various companies pending the adoption of the new sales policy, and the sales now announced are the result of closing negotiations following the adoption of the new policy.

OIL BURNERS LEAD IN VESSELS NOW BUILDING

More Than 830,000 Tons of Tankers Under Construction Will Use Liquid Fuel—Only 7.4 Percent of Total Ships Building to Use Coal Exclusively

The rapidity with which oil is replacing coal as fuel in American shipping is strikingly shown in an analysis of the tonnage now under construction for private account in this country.

Figures prepared by J. B. Crowley, statistician for the American Bureau of Shipping, show that of the freighter tonnage now building no less than 78.1 percent is being equipped exclusively for oil-burning. Cargo carriers fitted to burn both oil and coal form 14.5 percent of the total, while those constructed to burn coal represent only 7.4 percent of the aggregate.

It is also interesting to note that the ships burning only oil and both oil and coal are much larger than those equipped simply for coal burning. The oil burners average almost 4,000 gross tons each, and the combination oil and coal ships almost 6,000 gross tons, while the coal burners are of an average of less than 2,000 tons, or less than half the size of the other types. The number of freighters of the various types and their aggregate gross tonnage are as follows:

Oil burners	101	400,455
Coal-burners	20	38,171
Combination	13	74,567
Total	134	513,193

All the fuel-consuming tankers under construction are oil burners. There are 121 of these, aggregating 830,964 gross tons, an average of almost 7,000 tons per tanker. Non-propelled tankers aggregate 19, of 11,991 gross tons, as compared with 109 non-propelled cargo carriers of 82,350 tons.

According to Mr. Crowley's compilation there were building for private account on September 1 a total of 383 vessels, aggregating 1,438,498 gross tons. The division, according to classification by the American Bureau of Shipping, Lloyd's Register of Shipping, those classed by both these societies and a fourth group, composed of vessels classified by other societies or being built without classification, was as follows:

	American Bureau		Lloyd's Register		Dual Class		Other or None	
FREIGHTERS	No.	Tons	No.	Tons	No.	Tons	No.	Tons
Coal	9	26,580	4	7,710			7	3,881
Oil	27	158,627	36	129,328	21	91,020	17	21,480
Both	3	17,653	6	32,484	4	24,430		
Non-propelled	8	4,500					101	77,850
Total	47	207,360	46	169,522	25	115,450	125	103,211
TANKERS								
Oil	24	165,255	71	513,833	16	122,238	10	29,638
Non-propelled			8	4,671			11	7,320
Total	24	165,255	79	518,504	18	122,238	21	36,958
Grand Total	71	372,615	125	688,026	41	237,688	146	140,169

It will be noticed that while the American Bureau exceeds Lloyd's Register in the number and tonnage of freighters under construction, the latter society has a considerably larger lead in the number and tonnage of tankers being classified, while the non-propelled vessels are chiefly with the smaller societies or are not receiving any classification.

Mr. Crowley's figures also show that of the total tonnage under construction for private account, 25.9 percent is with the American Bureau, 47.9 percent with Lloyd's, 16.5 percent is dually classified, and the remaining 9.5 percent is either with other classification societies or is not being classed.

CONSOLIDATION EFFECTED

New Organization of United American Lines

The executive and freight traffic departments of the United American Lines, formerly Livermore, Dearborn & Company, agents of the American-Hawaiian Steamship Company and the American Ship & Commerce Corporation, took possession of their new quarters at 39 Broadway, New York, on September 7. The personnel of the new organization follows:

W. Averill Harriman, chairman of the board; W. G. Sichel, assistant to the chairman.

Executive—Harris Livermore, president; E. C. Tobey, assistant; Henry Dearborn, vice-president; Victor H. Thun, controller; F. W. Anderson, secretary; C. M. Fedderman, treasurer.

Freight Traffic Department—C. J. Beck, general freight traffic manager; H. H. Garvin, assistant; E. W. Relyea, manager, and J. J. Gilbride, assistant, in charge of Mediterranean and long voyage trades; J. E. Waldorf, manager, and B. F. Gaede, assistant, in charge of Continental trades; H. J. Kehoe, in charge of coastwise trades; C. E. Barry, Western manager, Chicago.

Passenger Traffic Department—E. Lederer, director of passenger traffic.

Operating Department—J. D. Tomlinson, manager; H. M. Wesson and H. R. Hanlin, assistants.

TANKER PLANS APPROVED

Seventeen Vessels Under Way and to Be Built Cost $39,000,000

There have been approved by the Shipping Board plans for seventeen bulk oil carriers, aggregating 216,800 deadweight tons, under section 23 of the Merchant Marine Act, which provides for the exemption of excess profits taxes if the proceeds are invested in new tonnage in American shipyards. The vessels will cost approximately $39,000,000 at the present price of about $180 a ton for future delivery.

Fourteen of the ships are to be built by the Standard Oil Company of New Jersey, one by the Pacific Mail Steamship Company, one by the Sun Company, and one by the Vacuum Oil Company.

Two are exceptionally large, of 20,300 deadweight tons each. These are to be built by the Newport News Shipbuilding & Dry Dock Company for the Standard Oil Company.

The plans approved are as follows:

Pacific Mail Steamship Company, New York City, one 9,800 deadweight ton oil tanker, to be built by the New York Shipbuilding Corporation.

Sun Company, Philadelphia, one 12,800 deadweight ton single screw bulk oil steamer, to be built by the Sun Shipbuilding Company, Chester, Pa.

Standard Oil Company, New Jersey, fourteen oil tank steamers as follows: Three vessels, 15,100 deadweight tons, Federal Shipbuilding Company, Kearney, N. J.; three of 10,100 deadweight tons, Moore Shipbuilding Company, Oakland, Cal.; two of 10,440 deadweight tons, Sun Shipbuilding Company, Chester, Pa.; two of 20,300 deadweight tons, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; three of 11,740 deadweight tons, G. M. Standifer Construction Corporation, Vancouver, Wash.; one of 11,900 deadweight tons, Oscar Daniels Company, Tampa, Fla.

Vacuum Oil Company, New York City, one 10,000 deadweight ton tank steamer, to be built by the Moore Shipbuilding Company, Oakland, Cal.

In approving the plans of the vessels the Board decided that they should be constructed to meet the classification requirements of the American Bureau of Shipping, and has adopted this requirement as a condition of its approval required by the provisions of section 23.

Board Plans for Marine Week

Announcement was made at the Shipping Board on September 13 of its participation in the plans for the celebration of National Marine Week at Chicago, October 18-25. Admiral Benson stated that the purpose of the Board is to assist in arousing the interest of the country in the importance of shipping and especially to convince young men that the sea holds out promises for a profitable profession.

NEW CONCERNS IN AUGUST

Capitalization of Shipping Companies Lowest So Far This Year

Shipping concerns organized in August, 1920, with an authorized capital of $50,000 or more, numbered twenty, as against eighteen in July. The aggregate capital of only $24,550,000, however, showed a decline compared with $26,250,000 for July, and a drop of more than 50 percent from the figures of August, 1919. The records kept by the *Journal of Commerce* show that the August figure is the smallest for any month so far this year.

During January-August of the current year the indicated investment in shipping and shipbuilding companies appears as $519,203,000, shipbuilding having attracted a far smaller proportion of the total than ownership and operation. The aggregate for the corresponding period of 1919 was only $196,786,000, the increase figuring out as well over 150 percent. As a matter of fact, this comparison does not bring out the impressiveness of the total for 1920 to date as does the statement that the largest aggregate for any year since the outbreak of the war, that for 1919, was but $323,613,000.

The average indicated investment per company in August figures out as $1,227,500, compared with $1,458,333 for July. For the other months of the year the average was as follows: June, $2,607,575; May, $999,469; April, $8,128,864; March, $2,945,237; February, $1,963,530 and January, $2,384,531.

Seven companies were organized in the month with an authorized capital of $1,000,000 or greater, as against only four in July. In June fifteen companies, with at least $1,000,000 authorized capital, were formed, a similar number being started in May. The record for the other months of the year shows thirteen concerns of such proportions organized in April, twelve in March, seven in February and ten in January, making the total for the first seven months of 1920, 76.

The following list comprises the names, States of incorporation and authorized capital of shipping companies organized in August, 1920, capitalized at $50,000 or more:

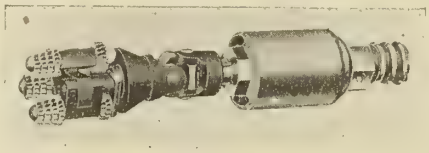
Brier Hill Steamship Co., Ohio	$1,000,000
Electric Steel Building Corp., Del.	600,000
Globe Line, Inc., Del.	2,000,000
Jarka, F. Co., Inc., N. J. (shipping)	100,000
Keans Transportation Co., Mass.	150,000
Lyn-dy-Shea Oil Transportation Corp., Del.	600,000
Lone Star Oil Transport Co., Md.	500,000
Liberian-American Steamship Co., Inc., Del.	500,000
Lysol, Inc., Del.	10,400,000
Northport Shipyard, Inc., N. Y.	100,000
North Atlantic Shipping & Agency Corp., N. J.	100,000
New York-Vistula Steamship Corp.	1,100,000
Pacific Packet Line, Wash.	1,200,000
Publicker Shipping Co., Del.	700,000
Service Line Corp., Del.	100,000
Slavia Transatlantic Corp., Del.	3,000,000
Seas Shipping Corp., Del.	100,000
Transo Steamship Corp., Del.	100,000
Trans-Shipping & Distributing Warehouse Corp., N. Y.	50,000
Winneton Shipping Co., Wash.	250,000
Total	$24,550,000

Air and Steam Drive Boiler Tube Cleaners

From time to time the matter of keeping boilers free of scale is brought to the attention of the industry, particularly after reports of the insurance companies indicate that explosions have been caused either directly or indirectly by the presence of non-conductors of heat on the tube walls. Not only must the tubes be kept clean to prevent possible explosions, but also to maintain every-day operating efficiency.

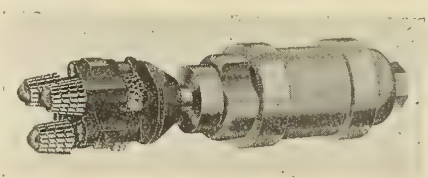
The mechanical means of removing scale has proved itself satisfactory over a long period of service, both from the point of view of economy and of positive action.

Some of the modern turbine-drive cleaners produced by the Lagonda Manufacturing Company, Springfield, Ohio,



Type No. 79 Cleaner for Curved Tubes

are typical in construction and operation of the best types of mechanical cleaners. Type No. 79, for example, is designed for use in 3¼-inch curved tubes of watertube boilers, such as the Sterling, Erie City, Maxim and Hyde types. This cleaner is constructed to remove the scale from the bends down to the iron, and, if properly operated, will not stall or have to be forced. The construction of this cleaner for either air or steam drive is such that



Type No. 80 Cleaner for Straight Tubes. Type No. 81 is Similar

a high rotative speed is imparted to the drive shaft by the impelling force delivered to four paddles enclosed in an elliptical case. Two of these paddles are always under pressure, so that there is no possibility of the cleaner becoming stalled if it is operated properly. The paddles bear against a hardened steel plate pressed into the main shell, which can be replaced when worn.

All wearing parts of the cleaners are high-carbon steel carefully tempered and ground. The rotor and center shaft are of one piece. An air or steam pressure of 80 to 100 pounds is required for most efficient operation, the consumption at this pressure being about 55 cubic feet per minute.

The quick-repair head and toggle joint are so arranged that they are most effective in removing scale from bends. Various other cutting heads may be used in combination with the toggle joint.

Another type of cleaner for straight tubes is also of interest. Nos. 80 and 81, for 3½-inch and 4-inch tubes, respectively, are especially adapted for use in the Heine, Babcock & Wilcox, Wickes, McNaull and similar type boilers. They may also be utilized in removing scale from economizer tubes and boiler feed water lines.

The motor in each case is similar to that described for Type No. 79 cleaner. A three-arm, quick-repair head is part of the standard equipment, as well as drill and porcupine heads, which may be used in combination with the toggle joint.

New Bedford to Have Lines for Carrying Cotton

New Bedford, Mass., which receives for use in its mills more than 2,000,000 bales of cotton a year, besides 200,000 bales for Fall River, is canvassing the possibilities of a proposal to establish its own steamship line to the cotton ports of the South.

A representative of the Massachusetts mill city has been over the ground at Savannah, New Orleans and Galveston, to ascertain what wharf space is available there, and is said to have secured an option on necessary berths.

Representations will be made to mill owners and managers at New Bedford regarding the economies to be effected through direct handling by sea of their cotton supply. At present the cotton comes by any available route, and with present traffic conditions deliveries are uncertain and cost of carriage high.

New Bedford has a new State pier well adapted to the needs of a cotton-carrying line, and such a line, with its freights assured, under proper management, ought to do well.

An example has been set to New Bedford in going into the coastwise steamship business by Norfolk, Va., which has established a line to take the place of the service abandoned by the Old Dominion Company, between Norfolk and New York, while Richmond, Va., is buying two ships to run to New York.

Japanese Lines Cannot Raise Passenger Rates

Passenger departments of steamship lines on the Pacific Coast have been notified that the Japanese Government refuses to permit Japanese lines to raise their passenger rates. The Japanese lines are subsidized and cannot raise rates unless granted permission by their government. The American lines cannot raise rates unless the Japanese do also.

The passenger conference some months ago decided to raise rates in proportion to expense of operation. The Toyo Kisen Kaisha and Nippon Yusen Kaisha, members of the conference, put in a request for permission to do this. It was not granted, and the Japanese Government said they should cut down their overhead. Passenger rates since the war began have increased only 25 percent across the Pacific.

DeLamater-Ericsson Memorial Tablets

At the annual convention of the American Society of Mechanical Engineers last December, a memorial meeting was held on the evening of December 3 in commemoration of the eightieth anniversary of the arrival in the United States of Capt. John Ericsson and his fifty years association with Cornelius H. DeLamater in engineering work. In advance of the meeting it had been decided to erect memorial tablets to mark the sites of certain buildings which were closely identified with the work of DeLamater and Ericsson. It was proposed to erect four tablets as follows: One at the Phœnix Foundry at Laight and West streets, where the first screw-propelled vessel in this country was constructed, and where many other original developments were made; one at Capt. Ericsson's residence, 26 Beach street, where he designed the *Monitor* and made all his inventions during his later years; one at the DeLamater Iron Works at the foot of West Thirteenth street, where the engines of the monitors *Puritan* and *Dictator* were built, as well as the first submarine boat, the first torpedo boat, the first torpedo boat destroyer, the first self-propelled torpedo, the first air compressors, the first ice machines, and many other industrial appliances now in general use; and one at the Continental Iron Works, Greenpoint, L. I., where the hulls of the *Monitor* and other warships were built.

It is believed that there are many marine and industrial firms, organizations and individual manufacturers and engineers who, if given an opportunity, would contribute to the tablet fund, especially to commemorate the invention of the screw propeller and the building of the *Monitor*. Those interested are requested to communicate with the DeLamater-Ericsson Tablet Committee, H. F. J. Porter, chairman, Room 1100, Engineering Societies Building, 29 West Thirty-ninth street, New York City.

Navy Men Visit Westinghouse Plant

Eight lieutenant commanders and one senior grade lieutenant of the United States Navy recently spent a week in the plant of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., studying manufacturing methods, with especial attention to marine apparatus in the process of construction. Besides the inspection visit through the plant, lectures were given to the navy men by engineers of the Westinghouse Company. The work which these men are doing is in connection with post-graduate work for a master's degree in engineering from the United States Naval Academy at Annapolis.

Mr. T. C. Allen, formerly comptroller of the Tacony Steel Company, has been appointed assistant to the president of the Penn Seaboard Steel Corporation.

HARRIMAN-KERR CONTROVERSY STIRS UP SHIPPING WORLD

Kerr Interests Control Ships Until October 24—Hamburg-American Deal Storm Centre—Millions More to Be Paid Before Matter is Settled—Benson Says Contract is All Right

When the Treasury Department seized $4,900,000 paid by the Harriman steamship interests for the stock in the Kerr Navigation Company held by H. F. Kerr and A. E. Clegg, on August 28, there started a contest which has developed into considerable magnitude, and stirred the shipping interests of the country to their limits.

The seizure, or rather sequestration, was ostensibly made with a view to looking after the tax interests of the Treasury in relation to excess profits, and Kermit Roosevelt, secretary and treasurer of the Kerr Steamship Lines, charged that W. A. Harriman, president of the American Ship & Commerce Corporation, inspired the seizure of the money, which was denied by Mr. Harriman. Then came the libel by American Ship & Commerce of the steamer *Kerlew*, operated by the Kerr Lines, and a temporary injunction restraining the operation of the libel.

Following this W. A. Harriman and R. H. M. Robinson, of American Ship & Commerce, and Ira A. Campbell, their counsel, were adjudged in contempt of court, but when they released the libel on the *Kerlew* no penalty was imposed under the contempt proceedings.

On behalf of the Harriman interests it was claimed that the Kerr Steamship Lines operated the ex-Austrian ships of the Kerr Navigation Corporation under a simple agency contract terminable at will. They charged that the Kerr Steamship Lines had failed to make an accounting at the end of each trip as required by contract; that they were from $200,000 to $350,000 in arrears; that they had used chartered Spanish tonnage on the Hamburg route while operating Kerr Navigation Corporation tonnage to South America, and that there were indications of secret profits and rebates.

Then Alfred E. Clegg issued a long statement reviewing the negotiations between the Hamburg-American and Kerr-Harriman interests, and charged that the contract between the American and German concerns was grossly inequitable and unfair to American shipping.

Rear Admiral Benson, chairman of the Shipping Board, later came into the quarrel, reaffirming his belief, announced when the deal first became known, that the agreement was a good thing, and that it did not provide in any way for a pooling of profits between the American Ship & Commerce and the Hamburg-American Corporations. The American Steamship Owners' Association republished the resolution passed in March last stating its opposition to any contract between an American concern and the Hamburg-American Line.

On September 16, Justice Lehman, in the New York Supreme Court, decided that the Kerr Steamship Company should be allowed to operate the vessels owned by the Kerr Navigation Corporation until October 24, after which all the vessels acquired by the Harriman interests may be operated by the owners.

The court action revealed that Alfred E. Clegg and H. Farquharson Kerr owned 75,000 shares of stock in the Kerr Navigation Corporation. In order to terminate the contract between the Kerr organizations, the Harriman interests must not only give ninety days' notice, but must purchase all of the stock held at $100 a share. Thus far only 49,000 shares of the stock have been purchased. Before the expiration of this period it will be necessary for them to pay over the additional $2,600,000 in cash. It has been announced that all of this money will be reinvested in new American ships.

The reason all of the 75,000 shares were not tendered for purchase on August 28 was that there are certain tax matters relating to 26,000 shares which had not been settled at that time.

Shipyard Receivers Appointed

Judge Manton, in the United States District Court, has appointed George Gordon Battle and Thomas B. Felder receivers for the National Shipbuilding Company, 42 Broadway, with shipyards at Three Rivers, Canada, and Violet, La., on application of Saul S. Meyers, representing creditors for over $1,000,000. An order of adjudication was also entered, and Seaman Miller was named as referee in bankruptcy. A petition in bankruptcy was filed against the company on August 21. Mr. Myers said that the liabilties were $5,000,000.

Shipping Board Loss on Concrete Tankers

Losses of more than $500,000 each were suffered by the Shipping Board in accepting the bids on the concrete tankers *Palo Alto* and *Peralta*, recently built at Oakland, Cal., in the opinion of shipbuilders. The Atlantic Refining Company, of Philadelphia, offered $825,000 for the *Palo Alto*, and the American Fuel Oil & Transportation Company, of New York, bid $700,000 for the *Peralta*. Two more of the concrete tankers are building at San Pedro.

BUSINESS NOTES

The Mono Corporation of America announces the removal of its main office from Buffalo, N. Y., to 25 West Broadway, New York City, where a complete line of the automatic continuously recording gas analyzing instruments manufactured by this corporation will be displayed.

The Pennsylvania Pump & Compressor Company, of Easton, Pa., announces the opening of additional sales offices in the following cities: Buffalo, N. Y., J. B. Laird, manager; Cleveland, Ohio, L. J. Wakefield, manager; St. Louis, Mo., Corby Supply Company; Minneapolis, Minn., L. E. Pollard Company, and Omaha, Neb., L. E. Pollard Company.

The Uehling Instrument Company, 71 Broadway, New York City, manufacturer of fuel economy equipment, announces that it is now represented in the New England States by the Smith Engineering & Supply Company, 89 State street, Boston, manufacturers' agents and engineers, specializing in power plant equipment. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Company, with headquarters in the New York office.

The Walter H. Taverner Corporation, electrical and mechanical constructing engineers, have opened offices in the Flatiron building, 175 Fifth avenue, New York City.

The export department of the Oxweld Acetylene Company, which was formerly located at the company's factory in Newark, N. J., has been removed to the Carbide and Carbon building, 30 East Forty-second street, New York. The department has been reorganized and is now under the direction of Mr. R. G. Noble.

The Mesta Machine Company has opened an office in the Singer building, New York, from which point all its foreign business will be handled. All foreign correspondence should be addressed to the company at New York. The New York office will also be the sales office for the New York and Eastern States' territory. Mr. M. M. Moore, the export sales manager, who has just returned from a several months' European tour, will be in charge.

The Associated Business Papers, Inc., 220 West Forty-second street, New York, will hold a convention at the Astor Hotel, October 20, 21 and 22. The members of the general convention committee are F. M. Feiker, McGraw-Hill Company, chairman; David Beecroft, Class Journal Company; E. H. Ahrens, A. W. Shaw Company; Aglar Cook, *Electrical Record;* E. E. Haight, *Motor Age*. The national editorial conference has appointed H. C. Parmelee, editor of *Chemical and Metallurgical Engineering*, chairman of their committee, which will work with the publishers' general committee.

TRADE PUBLICATIONS

Twist Drills and Reamers.—In a catalogue issued by the Whitman & Barnes Manufacturing Company, Akron, Ohio, specifications of carbon and high-speed twist drills and reamers of all types are given.

Rivets.—A book containing useful information on rivets, intended for purchasing agents, engineers, draftsmen, shop foremen and others interested, has been issued by the S. Severance Manufacturing Company, Glassport, Pa.

Material Handling.—The Buffalo Hoist & Derrick Company has issued a pamphlet giving the specifications and a few of the uses to which the clamshell buckets, locomotive cranes, derrick and hoisting engines produced by this company may be put.

Turret Lathe Practice.—A reference book on vertical turret lathe practice in railroad shops has been issued by the Bullard Machine Tool Company, Bridgeport, Conn. The book is valuable as a reference for quick, efficient methods of setting up locomotive parts and performing the necessary machine operation.

Convert-A-Caps.—A pamphlet giving details of a new electrical connection plug cap has been issued by the Benjamin Electric Manufacturing Company, Chicago, Ill. Portable electrical appliances equipped with the new cap may be operated from almost any base board or wall receptacle of the slotted variety now in use.

Crane Comment.—The latest bulletin published by the Industrial Works, Bay City, Mich., contains the story of crane construction as carried out in Industrial Works shops. It also describes a variety of locomotive crane uses, both in wrecking work and new construction. A table of capacities, weights and radii, with different length crane booms, is also given.

Insulating Materials.—Recent interesting and valuable bulletins by the General Electric Company, Schenectady, N. Y., include Nos. 48704A and 48715, dealing respectively with insulating compounds and insulating fabrics. A wide variety of materials for both purposes are illustrated and described. Other bulletins are No. 49400 on the Hewlett link insulator, and No. 41311 on synchronous condensers.

"WEW" Valve and Steam Specialties.—A new edition of the illustrated valve catalogue and price list of William E. Williams, 62 Front street, New York City, is intended to show the most important and more widely used types of valves in stationary and marine engine practice. Information regarding special valves and brass and iron castings of any description will be furnished by this company on request.

Bundy Oil Separator.—Bulletin No. 1130, describing the Bundy Oil Separator produced by the Griscom-Russell Company, 90 West street, New York City, has just been issued. In it the construction and specifications of the separator are given, together with its application in steam turbines and reciprocating engine pipe lines. One feature particularly mentioned is the design of the baffle plates, which permits easy removal and replacement when cleaning is necessary.

Electric Drills.—The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, is distributing a circular descriptive of Thor universal electric drills. A feature of this line is the size "oo" portable electric drill with pistol grip handle, which is useful under a wide variety of conditions, including drilling, reaming, boring in wood, screw driving, etc. Other tools are adapted for grinding as well as drilling, and all are driven from ordinary lamp socket conections.

New Condulets.—Bulletin No. 100-N of the Crouse-Hinds Company, Syracuse, N. Y., describes a new series of condulets produced by this company which are known as the Mogul series. These particular condulets are resigned to avoid kinking heavy wires or cables when pulling in or feeding them through a conduit system, and to afford ample space when making splices or taps. The condulets are made in eight types, each having eight sizes, ranging from 1 to 4 inches. Descriptions of the various types are listed in the catalogue.

McNab Encyclopedia of Marine Appliances.—This is a 206-page book, 9 inches by 12 inches, describing and illustrating the marine equipment produced by the McNab Company, Bridgeport, Conn. The book is primarily intended as a review of the latest developments in appliances and fittings for the construction and operation of ships. For convenience and reference, in addition to the general index, sectional indexes are given of appliances used by the hull, engine and electrical divisions as well as equipment used in navigation. The price of the book is $5.00, and it may be obtained from the McNab Company.

Spraguelets.—A catalogue describing conduit bodies produced by the Sprague Electric Works, New York, has just been issued. The principal features of this line of conduits are the knockouts and couplings which permit the assembly of conduit combinations that have not been possible with old tube bodies. The Spraguelet bodies are in three types and the couplings are designed for ½-inch and ¾-inch conduits, and are made to fit the one size knockout standard to all size bodies. Plates and covers for branch, deep and shallow body Spraguelets are listed and the entire line fully described.

Thermit Pipe Welding.—The thermit process of pipe welding as carried out by the Metal & Thermit Corporation, 120 Broadway, New York, is completely described in a catalogue recently made available. The pamphlet contains reports on successful tensile strength and vibration tests of thermit pipe welds conducted by the Stevens Institute of Technology. Among other tests described is one on 100 feet of 4-inch pipe which was ten years in service at West Albany, N. Y. This pipe was subjected to a hydraulic pressure of 1,500 pounds per square inch without revealing any defects.

Carbon Dioxide Equipment.—The Uehling Instrument Company, 71 Broadway, New York, has just issued bulletin No. 111 describing Style "U" Uehling carbon dioxide equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the features of the new machine are speedy action, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front indicator, which guides the fireman, while the recorder in the chief engineer's or superintendent's office makes a continuous record showing all changes in boiler adjustments conducive to either waste or economy.

Saving Lives at Sea.—Under this title the American Balsa Company, Inc., 50 East Forty-second street, New York City, has issued a booklet describing the necessity of equipping vessels with effective types of lifeboats, davits, rafts and other life-saving accessories. During the war many instances occurred when the lives of ships' crews and passengers were dependent on the efficiency of life-saving equipment. To a lesser extent in peace times a ship is dependent on this equipment, and so it must not be regarded in the light of minor outfitting to be left to the discretion of employees whose position compels them to place the question of a slight difference in cost ahead of the question of maximum safety. The booklet completely describes and illustrates various installations on cargo and passenger vessels, and takes up in detail the design of lifeboats, rafts, Welin quadrant davits and other life-saving devices.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Steamers, New York.—The Red D Line, it is reported, will ask for bids in October for two 280-foot steamers.

Tugs, San Francisco, Cal.—The Main Iron Works is constructing four tugs for the Ship Owners & Merchants Tug Boat Company.

Barkentine, Mahone Bay, N. S.—The Ernst Shipbuilding Company, Ltd., is building a barkentine, about 300 tons net, for private account.

Tankers, Oakland, Cal.—The Union Construction Company has a contract for three 8,400-ton oil tankers for the Anglo-Saxon Petroleum Company.

Lifeboats, Westville, N. J.—The Westvile Lifeboat Building Company has been incorporated, with a capital of $125,000, by Earl H. and Hagen A. Johnson to manufacture lifeboats, fittings, etc.

New Liner, North Vancouver, Wash.—The Wallace Shipyards will construct the new Canadian-Pacific liner that will replace the Princess Sophia, lost in 1913. The new ship will cost $1,000,000, it is said.

Tankers, Quincy, Mass.—It is reported that the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., has a contract for four tankers for the Standard Transportation Company, New York.

Repairing Tanker, Brooklyn, N. Y.—The tanker John D. Rockefeller, which was sunk in Tampico Bay last December, is being repaired by the Robins Dry Dock & Repair Yard. The work will cost $750,000.

Pontoons, Brooklyn, N. Y.—W. H. Gahagan, Inc., is constructing ten wooden floating drydock pontoons with a lifting capacity of 2,000 tons each for the Emergency Fleet Corporation of the Shipping Board.

Tankers, New York.—The Atlantic Coast Shipbuilders' Association has received inquiries for two oil tankers for immediate delivery. Information will be supplied by the association, 30 Church street, New York.

Diesel Engines for Freighters.—Two freighters to be built by the Harriman Shipbuilding Corporation for the American-Hawaiian Steamship Company are to be equipped with Diesel engines to be built by the Cramps.

Six Vessels, Gulfport, Miss.—The Gulfport Shipbuilding Company has a contract for building six ships for the Government. The boats will be equipped with high-powered engines and outfitted with all modern facilities.

Tankers, England.—The Admiralty has issued orders for the construction of four additional oil-tankers in the National Dockyards, one each at Portsmouth, Devonport, Pembroke and Sheerness, at an estimated cost of £120,000 each.

Motorships, New York.—The Peruvian Steamship Company, 42 Broadway, is reported by the Guaranty Trust Company, 140 Broadway, to be in the market for four motorships of the Diesel engine type, of about 8,000 deadweight tons each.

Freighter, Vancouver, B. C.—The keel for a fifth steamer for "yard account" has been laid by Coughlan & Sons, and it will be of the same type as the preceding four built to the firm's own order. She will be of 8,800 deadweight tons, and will probably burn oil.

Tankers, Prince Rupert, Can.—W. P. Hinton, vice-president of the Grand Trunk Pacific Railway, announces that the Prince Rupert Drydock & Engineering Company has closed a contract for building five steel tankers. Newman C. Erb, of New York, controls this company.

Convert Freighters, Pensacola, Fla.—Five freighters, bought from the Shipping Board by the American Fuel Oil & Transportation Company, of 7,285 tons deadweight each, will be sent to the Pensacola Dry Dock & Shipbuilding Company to be converted into bulk oil carriers.

Tankers, San Pedro, Cal.—The Anglo-Saxon Petroleum Company, a subsidiary of the Royal Dutch Shell Oil Company, has placed a contract with the Southwestern Shipbuilding Company for the construction of three Isherwood framed tankers of 8,400 deadweight tons each.

To Convert Hulls, Portland, Ore.—The wooden hull Egeria, 3,500 deadweight tons, has been bought by H. W. Pennell and associates, of Portland, and will be converted into a steam schooner. The Acarmen, another of the hulls recently sold, is to be converted into a barkentine.

Ferryboat, New York.—Bids have been called for in the preliminary plans for the construction of a new ferryboat for use to Staten Island. Grover A. Whalen, Commissioner of Plant and Structures, will issue the call and the bids will be opened October 11. The estimated cost of the boat is $600,000.

Barges, Bath, Me.—The Kelly-Spear shipyard, which has been idle for several months, is to start up again, Manager Sawyer having obtained contracts to build two coal barges of 3,000 tons deadweight capacity each for the Staples Transportation Company, of Fall River, Mass., to be completed in ten months.

Combination Ships, Sparrow's Point, Md.—The Bethlehem Shipbuilding Corporation will build two 20,000-ton ore and oil carriers of a combination type for the purpose of doing away with empty voyages either to or from loading points. The vessels will be adapted to carrying oil to South America and return with ore.

Rebuilding Steamer, Brooklyn, N. Y.—The steamer Brazos, of the New York & Porto Rico Line, is to be rebuilt by the Robins Dry Dock & Repair Company. She will be converted into an oil burner, a new deck added and her accommodations improved. Theodore E. Ferris has made the plans, and the cost will be about $1,250,000.

Barges, St. Helens, Ore.—A contract for the construction of two large barges for Swift & Co. has been signed by Captain J. H. Roberts, Portland, Ore., business representative of the St. Helens Shipbuilding Company. Work on the two barges is to start at once. The two barges will be 130 feet long, 34 feet wide and 7 feet deep.

Car Floats, Elizabeth, N. J.—The Moore plant of the Bethlehem Shipbuilding Corporation, Ltd., has a contract to build two car floats for the Western Maryland Railroad Company. Each will carry 22 railroad cars, and will be 347 feet long, 43 feet 7 inches beam and 11 feet 6 inches molded depth amidships, and will be completely equipped.

Tankers, Vancouver, Wash.—The G. M. Standifer Construction Corporation has received a contract from the Imperial Oil Company of Canada for two 12,000-ton tankers. Each boat will require 2,700 tons of plates and 1,500 tons of shapes. Deliveries on this material will start in October. Eastern plate and structural mills have the inquiries for this tonnage.

Steamships, Rio de Janeiro, Brazil.—A new shipping company, the Companhia Nacional de Transportes Maritimos Uniao Luse Braziliera, proposes to place orders soon for twelve steamships of about 2,000 tons each. The company will establish a line between Portugal and the Portuguese colonies, New York, Central America, Hamburg and other European ports.

Reconditioning Sailing Ships, San Francisco, Cal.—Eleven big German ships which were interned at Santa Rosalia, Mexico, during the war, are to be towed to San Francisco, where they will be cleaned and repaired. The vessels are the Adolph Vinnen, Egon, Hans, Havestebude, Orotava, Reinbek, Schubek, Walkure, Wandsbele, Thielbek and Lasbele.

Life Rafts, Saginaw, Mich.—The American Safety Navigation Company, a $30,000,000 corporation, contemplates the erection of a plant costing about $15,000,000, to manufacture aluminum life rafts for use on seagoing vessels. Options have been obtained on 1,400 feet of river frontage, with a depth of 450 feet. R. W. Carnahan is vice-president and general manager.

To Alter Ships.—It is reported that the two 10,500-ton deadweight cargo carriers which the Merchant Shipbuilding Corporation is building at its Chester, Pa., yard for the Shawmut Steamship Company, of New York, are to be altered for third-class passenger service. A description of the original design of these vessels was published on page 714 of our September issue.

Steel Vessels, Oakland, Cal.—With the launching recently of the steamer Heber by the Union Construction Company that concern completed its original contract with the Emergency Fleet Corporation for ten steel cargo vessels, and is now able to accept contracts from private concerns. In addition to new contracts, the company has under construction eleven other private vessels.

To Repair Steamer, Quincy, Mass.—The Shipping Board steamer Trimountain, operated by McAllister Bros., 24 State street, New York, has gone to the Fore River yard of the Bethlehem Shipbuilding Company, where she will undergo repairs to her Scotch boilers, which were built at another plant. Three furnaces are being renewed and six others are being jacked back to their original shape.

Concrete Tankers, San Diego, Cal.—The Pacific Marine & Construction Company is building two reinforced concrete tankers of 7,500 tons deadweight capacity for the Emergency Fleet Corporation. One of these tankers, the Cuyamaca, has been chartered by the France & Canada Steamship Company, of New York, and the other, the San Pasqual, by the Columbus Shipping Company, of New York.

Construction of Transport.—The Virginia Shipbuilding Corporation was the lowest bidder for the construction of the transport Heywood, at a price of $2,493,000. Other proposals were from the Bath Iron Works, Todd Dry Dock & Construction Corporation, Bethlehem Shipbuilding Corporation, Union Construction Company, Downey Shipbuilding Corporation, and William Cramp & Sons Ship & Engine Building Company.

Contracts Canceled, Sparrow's Point, Md.—The Bethlehem Shipbuilding Corporation has received notice from the Shipping Board of its intention to cancel contracts for construction of the last three 535-foot combination passenger and cargo liners, because of delay in deliveries. These vessels were estimated to cost about $6,000,000. They were to be of 13,000 deadweight tons, with engines capable of developing a speed of 18 knots.

Towboats, Seattle, Wash.—A. W. Carlson, who bought the Duwamish shipyard of the Inter-Ocean Barge & Transport Company, has built a towboat for Henry G. Seaborn's lumber schooner Camano, and has orders for several more for the same owner. In addition he will convert a former navy subchaser into a cruiser yacht for George Trahey, dockmaster at the Naval Station, Puget Sound, and has other contracts in sight.

Motorship, Tacoma, Wash.—A contract for a steel 6,500-ton motorship has been awarded to the Todd Dry Dock & Construction Corporation by the Alaska Steamship Company. The vessel will be 360 feet overall, 49 feet 6 inches molded beam, 26 feet 9 inches molded depth, draft, loaded, 22 feet. It will be propelled by two McIntosh & Seymour true Diesel engines of the four-cycle type, each having six cylinders and developing 1,200 indicated horsepower at 140 revolutions per minute.

Tankers, Wilmington, N. C.—The Syros, the eighth and last ship of the contract for 9,600 dead weight ton freighters, which the George A. Fuller Company, Wilmington, N. C., had with the Emergency Fleet Corporation, was successfully launched on September 18, making an average of a ship every seven weeks since the first launching about a year ago.; keels are laid and work well under way for the two 9,200 dead weight ton tankers which the George A. Fuller Company is building for a British oil company. These tankers are to be delivered in January and February, 1921, which will be a record for this yard.

To Build Battleship, Quincy, Mass.—The Fore River yard of the Bethlehem Shipbuilding Corporation, Ltd., is to build the world's largest, most powerful and fastest battleship for the United States Government. She will be called the Lexington, and will have a main battery of eight 6-inch guns, a full complement of smaller guns, and with electric propulsion developing 180,000 horsepower, is designed to have a speed of 35 knots, obtained partly through the use of armor plate exceptionally strong, but of only 5 inches thickness. She will be 874 feet long over all, with a beam of 101 feet and 43,200 tons displacement.

SHIPYARDS AND DRY DOCKS

New Repair Plant, Baltimore, Md.—The Sun Machinery & Iron Works, Stewart Building, was organized, with a capital of $25,000. Harold Johnson, president.

Shipyard Expansion, Quincy, Mass.—The Bethlehem Shipbuilding Corporation recently purchased two acres for its Fore River Works for expansion when required.

Plants Absorbed, Galveston, Tex.—The Gray's Engineering Works has acquired the plants and business of the Marine Iron Works and the International Iron Works.

Machine Shop, Norfolk, Va.—The Marine Iron Works Company, Inc., is having plans prepared for a two-story machine shop, 60 by 75 feet, to cost about $75,000. R. O. Colonna is president.

Dry Dock, Havre, France.—A floating repair dock capable of taking vessels of over 300 yards long, has been successfully launched. It is said to be the largest structure of its kind.

New Shipbuilding Plant, Germany.—Under the name of Die Neue Oderwerft, a new shipbuilding firm has ben established at Frauendorf, near Stettin, with the participation of Stettin insurance companies.

Shipyard Expansion, Elizabeth City, N. J.—The Elizabeth City Shipyard Company has added to its equipment an electric welding plant for use in connection with ship construction and repair and machinery repair work.

Shipyards Bought.—It is reported that A. C. Pessano has bought the plants of the Great Lakes Engineering Works at Ecorse and Detroit, Mich., and Ashtabula, Ohio, a stockholders' meeting having voted in favor of the sale.

Ship Repair Plant, Jacksonville, Fla.—It is reported that the Saliger Ship Salvaging Corporation, of New York, has secured a 300-foot water-front site to establish a dry dock, repair and salvaging plant. Frank Davenport is Southern representative.

Marine Railway and Dry Dock, Oakland, Cal.—Orders are being placed by the Hanlon Dry Dock & Shipbuilding Company for material to be used in building an additional marine railway. Plans and specifications for a floating dry dock are in preparation.

Shipyard Improvement, Quincy, Mass.—The Aberthaw Construction Company, 27 School street, Boston, has contract for building an addition to the power house at the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd.; about $75,000.

Shipyard to Reopen, Moss Point, Miss.—The Hodge Ship Company will reopen its plant in October, according to plans worked out for the construction of barges and medium-sized vessels there. The plant was created by the Emergency Fleet Corporation.

Shipyard Improvement, Oakland, Ca.—The Moore Shipbuilding Company has filed plans for a three-story reinforced concrete machine and construction shop to cost about $105,000. It has been awarded a contract for a 10,000-ton tanker for the Vacuum Oil Company.

Shipyard for Sale, New London, Conn.—The plant of the New London Marine Iron Works, recently used as a ship repair yard, has been placed on the market. The property is improved with a number of buildings, including machine shop, foundry, power plant, etc.

Shipyard for Sale, Mobile, Ala.—The Shipping Board has asked for bids on the shipyard formerly operated by Fred T. Ley & Company. The property has a pier 1,380 feet long by 40 feet wide and about three miles of railroad track. Bids will be opened in Washington, October 8.

Dry Dock, Vancouver, B. C.—The contract for the $3,000,000 dry dock on Burrard Inlet by J. Coughlan & Sons has been signed in Ottawa, and contains a provision that the work is to be started within sixty days of the completion of the deed. This means the construction of the dock should be commenced before the end of September.

New Ship Repair Company, New York.—The College Point Dry Docks & Supply Company has been incorporated, with a capital of $200,000, by G. F. Losche, E. B. Hallett and A. P Anderson, 34 Nassau street, to manufacture iron and steel castings for marine service and operate a ship repair plant.

New Plant, Brooklyn, N. Y.—Stephen Ransom, 401 West street, New York, operating a marine repair works, has filed notice of change of name to the Stephen Ransom Dry Dock & Repair Corporation. The company is building a new plant on Hamilton avenue to cost about $250,000, including equipment.

Drydock Nearing Completion, Portland, Oregon.—The first section of the new 15,000-ton drydock under construction for the Commission of Public Docks, was launched recently. The second pontoon is nearing completion and the third is now under construction. The drydock will be ready by January, 1921.

Shipyard Expansion, New Windsor, N. Y.—The proposed new building of the Newburgh Shipyards, Newburgh, N. Y., will be equipped for fabricating steel plates and shapes for ship construction. A large crane will be operated along the center of the east side of the building and two 80-foot cranes will be used through the center and west side.

Will Enlarge Plant, Elizabeth, N. J.—The Bethlehem Shipbuilding Corporation has arranged an improvement programme to cost about $1,000,000 at its Moore plant. A number of new buildings will be constructed and plans for the erection of the first of these, to cost $175,000, have been completed. The yard is now employing about 1,200 men, with weekly payroll aggregating approximately $40,000.

Dry Dock and Ship Repair Plant, Norfolk, Va., purchased a large tract of land adjoining the Norfolk & Western Railway piers, where a dry dock and ship repair plant calling for the expenditure of about $5,000,000 will be built. The dry dock will be of the floating type and will contain all the most modern improvements. Construction will be in charge of the Home Corporation, of which E. A. Miller is first vice-president.

New Yard Planned, Muskegon, Mich.—A site covering more than 100 acres on the north shore of Muskegon Lake has been secured by a group of Chicago and Milwaukee business men, who plan to construct shipbuilding yards which will cost around $1,000,000. This company, it is understood, will be a $3,000,000 company to start with. When the plant is equipped to handle ships two dry docks will be constructed.

Will Build Vessels, Savannah, Ga.—Eli Ness, who bought the South Side shipbuilding plant at Jacksonville, Fla., will improve the property and operate it for the building of ships. The plant was formerly owned by the Merrill-Stevens Shipbuilding Corporation, and was taken over by the Shipping Board. The sale was on the agreement that the new owner would operate the plant as a going concern for a period of five years or else pay the city $100,000 damages.

PORT IMPROVEMENTS

Dredging, Yarmouth, N. S.—The Department of Public Works, Ottawa, will soon receive bids for dredging the harbor here. About $49,880.

Wharf, New Orleans.—The Dock Board, Tiley McChesney, secretary, plans to extend and repair Pauline street wharf; Alexander & Juliani, contractors; $24,000 appropriated.

New Orleans Improvements.—The General Assembly of the State of Louisiana has approved an appropriation of $6,500,000 for improvement of the harbor and dock facilities.

Coal Docks, Savannah, Ga.—Savannah Coal Dock Company was chartered, with a capital of $600,000, by Samuel B. Howard, Raymond J. Gorman and Robert K. Thistle, all of New York.

Bulkhead, Sewell's Point, Va.—The Norfolk & Portsmouth Belt Line Railroad will build a bulkhead at Sewell's Point and also dredge in front of same. George D. Shafer, Nofolk, Va., is president.

Wharf, St. Francois D'Orleans, Que.—The Department of Public Works, Ottawa, Can., let contract for repairing the wharf to S. Rattee, St. Anne de Beaupre. About $33,000, cost plus percentage basis.

Municipal Docks, Portsmouth, Va.—The City Council plans an appropriation of $3,500,000 for freight-handling machinery, conveying and loading machinery, cranes, etc., for the city's new municipal docks.

Pier, Los Angeles, Cal.—The Common Council retained Barnard & Leeds, consulting engineers, Central Building, to prepare plans for a new municipal pier of mole type at San Diego. Bonds voted for project.

Foundation Piers, Oswego, N. Y.—E. S. Walsh, Superintendent of Public Yorks, Albany, N. Y., will receive bids until October 13 for building concrete foundation piers for proposed grain elevator on Barge Canal terminal pier.

Pier, Manila.—The Pacific Mail Steamship Company will build a large private pier, permission having been obtained from the Philippine Government. The pier will be four times larger than any at Manila at the present time.

Harbor Improvement, Port Stanley, Ont.—Department of Public Works, Western Building, Ottawa, Canada, is having plans prepared by J. B. Hunter, engineer, for harbor improvements and new swing bridge at Port Stanley, Ont. About $350,000.

Dock, Minneapolis.—Minneapolis, St. Paul and Sault Ste. Marie Railroad, Soo Line Building, is having plans prepared for a 1,250-foot concrete and steel dock, 500 feet wide across face. About $1,000,000. E. A. Whitman, Minneapolis, chief engineer.

Terminal, San Francisco, Cal.—Plans for a multiple-story ocean and rail warehouse terminal at Channel street were approved by the Board of State Harbor Commissioners. The improvement will cost about $2,300,000, and work will commence within sixty days.

Canal, Port Talbot, Ont.—The Great Lakes and Atlantic Canal & Power Company, Ltd., care of N. M. Cantin, president, St. Joseph, Ont., is having surveys made for a 43-mile canal, 400 feet wide, 35 feet deep, from Port Frank to Port Talbot; about $50,000,000.

Locks, Bell Island, Ill.—F. I. Bennett, Director of Public Works and Buildings, Division Waterways, 25 East Jackson Building, Chicago, Ill., will receive bids until October 18, 1920, for building Marseilles Lock, near Bell Island, in Illinois River. M. G. Barnes, chief engineer.

Port Terminal, San Francisco, Cal.—Plans have just been approved by the California State Board of Harbor Commissioners for a $2,300,000 six-story ocean and rail warehouse terminal to be constructed. The largest ship may dock there and cargo may then be put in storage at the harbor front.

Piers, Bulkheads, Etc., Brooklyn, N. Y.—E. S. Walsh, superintendent of Public Works, Capitol, Albany, N. Y., will receive bids until October 13, 1920, for driving foundation piles for proposed grain elevator, building bulkhead wall along Henry street slip and dredging Henry street basin at Gowanus Bay.

Municipal Dock, Wilmington, N. C.—The City has purchased the Liberty Shipyard plant in that city for $37,500. The yard was used to build vessels for the Government during the war, and will be used as a municipal dock, the land covered by the yard having been mainly donated by the citizens of the town.

Channels Chillicothe, Mo.—Grand River D. D., Livingston and Linn Counties, are having plans prepared by the Morgan Engineering Company, Goodwyn Institute, Memphis, Tenn., for 30-mile cut-off channels from 10-100-feet base in the Grand River, also river improvements involving 4,000,000 cubic yards drag-line excavation. J. T. Millbanks, chairman.

Pier Reconstruction, New York City.—The Commissioners of the Sinking Fund have adopted a resolution recommending the issue of corporate stock in the sum of $315,000, for building a shed and reconstructing the pier at East 24th street, and dredging the slips to a depth of 25 feet. A lease of the pier was granted to Carroll, Hagan & Carroll for a term of ten years.

Wharf and Shed, Manchester, Texas.—A wharf and shed costing $300,000 is to be built on the Houston Ship Channel, on a site to be deeded to the city by the Manchester Corporation. The deed is for twenty acres of land with a 1,500-foot channel frontage, and sufficient land to extend the municipal belt line through the Manchester property. Money for the work is available.

Harbor Improvement, Korea.—The Harbor of Fusan, in Korea, is to be greatly improved. The present harbor facilities having been found inadequate to meet the growing trade, and a new plan is under consideration to build a breakwater 1,800 yards long and to extend the two existing piers by 800 yards, to reclaim 27,500 tsubo of land and to dredge 220,000 tsubo to a depth of 24 feet. It is estimated that the work will cost over 9,000,000 yen and take six years for completion.

Pier Equipment, Etc., Brooklyn, N. Y.—Cranes, hoisting, conveying and other machinery will be installed at the new piers and warehouses to be constructed by the American Chain of Warehouses, Cleveland, Ohio, A. H. Greeley, president, on Mill Basin, Jamaica Bay. A proposition has been tendered by the company to the New York Dock Department covering a leasehold of the site for fifty years. It is proposed to build six piers and four supporting warehouses, with a total cost estimated in excess of $525,000,000.

Harbor to be Developed, Koenigsberg, Germany.—Plans for the projected expansion of Koenigsberg harbor include the construction of a tugboat harbor with a depth of 3.5 meters (1 meter = 3.28 feet) at the upper end of the city; the dredging and straightening of the river Pregel at Cosse, for which undertaking 900,000 marks have already been voted, and the construction of five harbor basins on the left bank of the Pregel. The city's commerce was seriously hampered by the shallowness of the harbor and the lack of facilities in the harbor for handling even the smalest vessels.

Pier and Dock Construction, Equipment, Etc., Philadelphia, Pa.—George F. Sproule director Department of Wharves, Docks and Ferries, has sent a communication to the Mayor covering the proposed programme for pier and dock construction, estimated to cost $20,000,000, including cranes, hoisting, conveying and other necessary machinery. Immediate construction estimated at $11,000,000 is to include new piers, 110-112 South Wharves, each 300 feet wide by 1,200 feet long, to cost $4,000,000 each, with machinery installation. Other work will include the construction of similar structures at the Moyamensing Pier group.

To Build Docks, Vancouver, Wash.—The city of Vancouver proposes to have a municipal dock built on the public levee. The estimated cost of the dock is $130,000, including dredging, and $200,000 worth of structures are already on the levee, which can be utilized. The proposed dock will care for two ocean-going ships at the same time, in addition to smaller craft. Plans include both open and closed docks, the former being 465 feet long and the latter 500 feet; warehouses, 500 x 100 feet; facilities for handling 100,000 tons of cargo and 50 railroad cars at the same time. Storage capacity will be for two ocean ships. Small ocean and river steamers can be accommodated until the 30-foot channel is secured.

GOVERNMENT WORK

Dredging, Appomattox River, Va.—U. S. Engineer Office, Norfolk, Va., will receive bids up to noon, October 22, for dredging in Appomattox River, Va. Information on application.

Bulkhead, Etc., Tampa (Fla.) Harbor.—Work will be begun soon on a Government engineer depot at Seddon Island. A bulkhead will be built and coal bins and oil houses will be erected.

Mine Yawls.—Quartermaster General, Transportation Service, Munitions Building, Washington, D. C., will receive bids until 11 A. M., October 4, for construction of 24-foot motor mine yawls. Plans and information on request.

Dredging, Providence, R. I.—Sealed proposals will be received at the United States Engineer Office, until 1 P. M. (standard Eastern time), October 11, 1920, for dredging in Thames River, Conn. Further information on application.

Steel Barges, Nashville, Tenn.—Under bids opened September 13 by the United States Engineer Office the contract for furnishing four steel barges was awarded to the Chas. Ward Engineering Works, Charleston, W. Va., at $66,000.

Steel Barges, Memphis, Tenn.—Sealed proposals will be received at the office of the Mississippi River Commission, First and Second Districts, Custom House, until 11 A. M., October 11, 1920, for furnishing five steel barges. Further information on application.

Tracks for Drydock, South Boston, Mass.—Specification 4196, the Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract for completing railroad tracks for the U. S. Naval drydock at South Boston, Mass., to M. Seretto, 3 Tremont Row, Boston; $134,750 (120 days).

Iron Sinkers, Tompkinsville, N. Y.—The Superintendent of Lighthouses will open sealed proposals at 3 P. M., October 4, 1920, for 103 cast iron sinkers, each with forged mooring shackles, sinkers to vary from 1,850 to 6,500 pounds each, total approximate 220 tons. Further information on application.

Seaplane Runway, Hampton Roads, Va.—Specification 4267, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for building seaplane runway at Naval Operating Base, to have wood piles, concrete walls, piers and platform; $10 deposit required for plans and specifications.

Foundation for Turrets and Crane Tracks, Philadelphia, Pa.—Specification 4299, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for building concrete foundations for turrets and crane track at the Philadelphia Navy Yard; $10 deposit required for plans and specifications. Further information on application.

Steel Buoys, Tompkinsville, N. Y.—Sealed proposals will be opened by the Superintendent of Lighthouses, Tompkinsville, N. Y., at 3 P. M., October 14, 1920, for 83 steel buoys of various types and sizes, some with bells and whistles, some with superimposed skeleton steel towers, and the majority with bottom counterweight iron castings. Information on application.

Steel Dump Scows.—United States Engineer Office, Philadelphia, will receive bids until October 14 for the building and delivery of two, three or four seven-pocket steel dump scows of the bottom-dump type, each of about 850 cubic yards capacity. The number to be furnished will depend on the price bid; funds are available for the purchase of two, and as many more will be purchased as the price will permit. Full particulars on application; blueprints, $1.

SHIPPING DEVELOPMENTS

Boston-Oriental Service.—The Barber Steamship Lines may establish a freight service from Boston to ports of the Far East.

New Steamship Line, Gulfport, Miss.—The Gulfport Fruit & Steamship Company has been incorporated, with a capital of $100,000, by Joseph Van Cooster, J. H. Lauf and John C. Simpson.

Steamship Company Formed, New York.—The Julius Kessler Steamship Company has been incorporated privately for the purpose of promoting trade with Canada, the United States and the West Indies.

Service to Greece, New York.—There is talk of establishing passenger service between New York and Piraeus and Constantinople, due to a realization of opportunities in the Greek and Turkish fields.

Steerage Service, New York.—The Hamburg-American Line announces that in January, 1921, it will resume its regular steerage service to New York with an 8,800-ton steamer, with other steamers following in February and March.

Steamer Sold, Mentor, Ohio.—The steamer H. H. Potter, the last of the four 600-footers built by the American Ship Building Company on its own acount to be sold, has been taken over by the Brier Hill Steamship Company, of Mentor, Ohio, recently organized.

For Business With Germany.—Plans are being made for the incorporation of the Buckeye Steamship Company to carry on a package business with Germany and Central European countries with wooden steamers. Ohio men are said to be concerned in the enterprise.

New Service to Cuba, New York.—The Oconee Steamship Company was recently incorporated to operate from New York to Guantanamo, Manzanilla, Santiago and Cienfuegos, the first steamer being the Oconee. The general manager is C. K. West, 9 Hanover street, New York.

Hamburg-New York Service.—The Luckenbach Steamship Company will inaugurate a cargo service from New York to Hamburg, with the sailing on October 6 of the first of the two fast freighters assigned for this operation. Other steamers will be placed on this service if tonnage warrants it.

New Line to Cuba, Pensacola.—A new steamship line between Pensacola and Mantanzas, Cuba, will be established by the Gulf, Florida & Alabama Railroad, according to H. W. Stigler, agent for the line in Memphis. The first ship will sail from Pensacola soon, and freight will be accepted for all points in Cuba, including Havana.

Steamship Company, Beaumont, Texas.—A new steamship company has been organized, with a capital of $300,000, it is announced by William Saenger, of Beaumont. Plans include the construction of two 4,000-ton steel ships to ply between Beaumont, Orange, Port Neches and Port Arthur, and Porto Rico, Vera Cruz, and Tampico.

American-Scandinavian Service, Philadelphia.—Plans for a joint port service between Philadelphia and Boston and Scandinavian ports, with regular sailings, have been completed by Charles T. Megee & Company, of Philadelphia, and C. H. Sprague & Son, of Boston. They will start operation with six freighters, and it is expected sailings will take place every three weeks.

Boston-U. K. Line.—The North Atlantic & Western Steamship Company, Inc., F. E. Gignoux, of Portland, Me., president, announces the establishment of a freight service between Boston, Portland, Liverpool and Glasgow. The company operates under the name of the Nawsco Line, the same name being given to the service the company plans between Boston and Pacific ports.

Barges and Tugs, New Bern, N. C.—Plans for purchasing six barges and two tugs for the proposed barge line between New Bern, N. C., and Baltimore, Md., stopping at Elizabeth, Washington and Norfolk, are in charge of W. F. Aberly, Wade Meadows and Harry Barlow, of New Bern, and Charles Flynn and Captain Lynch, of Washington. It is expected to have this line operating within a few weeks.

The Isthmian Steamship Line, operating ships built by the Chickasaw Shipbuilding & Car Company, Mobile, Ala., from Mobile to Rotterdam, has just established a port engineer's office at Mobile, which will be in charge of all repairs in the engine rooms and the buying of supplies for repairs, and will report to the head offices of the line in New York. R. V. & J. S. Taylor are agents for the line at Mobile.

Salvage Steamer Planned, San Francisco.—The recent stranding of the Dutch steamer Arakan near San Francisco has resulted in the shipping men of that city deciding that they must have an up-to-the-minute salvage steamer, with full equipment, ready for service at all times. According to those interested, the cost of the upkeep of such a vessel could be met in part by assessments on shippers and marine underwriters.

Sale of Kerr Ships, New York.—H. F. Kerr and Alfred E. Clegg, president and vice-president of the Kerr Steamship Company, have disposed of their interests in the fleet of ex-Austrian and ex-German cargo carriers which they controlled to the Harriman interests, and the ships will be turned over to the United American Lines. They also intend to dispose of large amounts of stock of the American Ship & Commerce Corporation to the same interests. The sum paid for the ships is said to be $5,000,000 in cash, which works out at a valuation of about $150 a deadweight ton.

Joint Terminal, Seattle, Wash.—A deal making the Skinner & Eddy yard, one of the largest ocean shipping centers on the Pacific Coast, was closed recently. The property totaling twenty-five acres will become the Puget Sound terminal of the Intercoastal, and a great trade fleet of the Isthmian Steamship Line, also the fleet of the Societe Generale des Transport a Vapeur of Marseilles, France. Twenty-five American steamships and three French ships aggregating a deadweight tonnage of 271,27., will ply to and from the terminal to ports of the Atlantic, Great Britain, France and North Africa.

Steamship Merger, Los Angeles, Cal.—Consolidation of the Los Angeles Steamship Company with the Los Angeles Pacific Navigation Company was announced by the officials of the Los Angeles-Pacific. Fred L. Baker, president of the Los Angeles Steamship Company, displaces L. D. Dale as president of the parent company. A. J. Frey will be general manager of combined operations. To this service will be added the steamers Yale and Harvard, now being overhauled. Acquirement of additional terminal facilities and enlargement of its fleet both by purchase and allocation from the Shipping Board are among the plans in early prospect of consummation.

South American Service, Philadelphia, Pa.—A recently organized firm for the development of direct service between Philadelphia and Ecuador is Chapman & Fisher, 524 Walnut street. Captain John H. Fisher, who has had long experience in marine transportation in Southern trades, is one of the senior members of the firm, and has taken Mr. Chapman, formerly with the Cramp shipyards and the Eastern Steamship Corporation, with him. The firm proposes to develop a business proposition between this country and Ecuador, of which two vessels, now under construction, are to be for a subsidiary organization. The firm is also associated with the Anchor Shipbuilding Company, of Washburn, Wis., constructing any type of vessel for lake or ocean service. Robert Kerr is vice-president and manager of the Anchor concern.

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29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
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NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
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INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

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Marine Engineering

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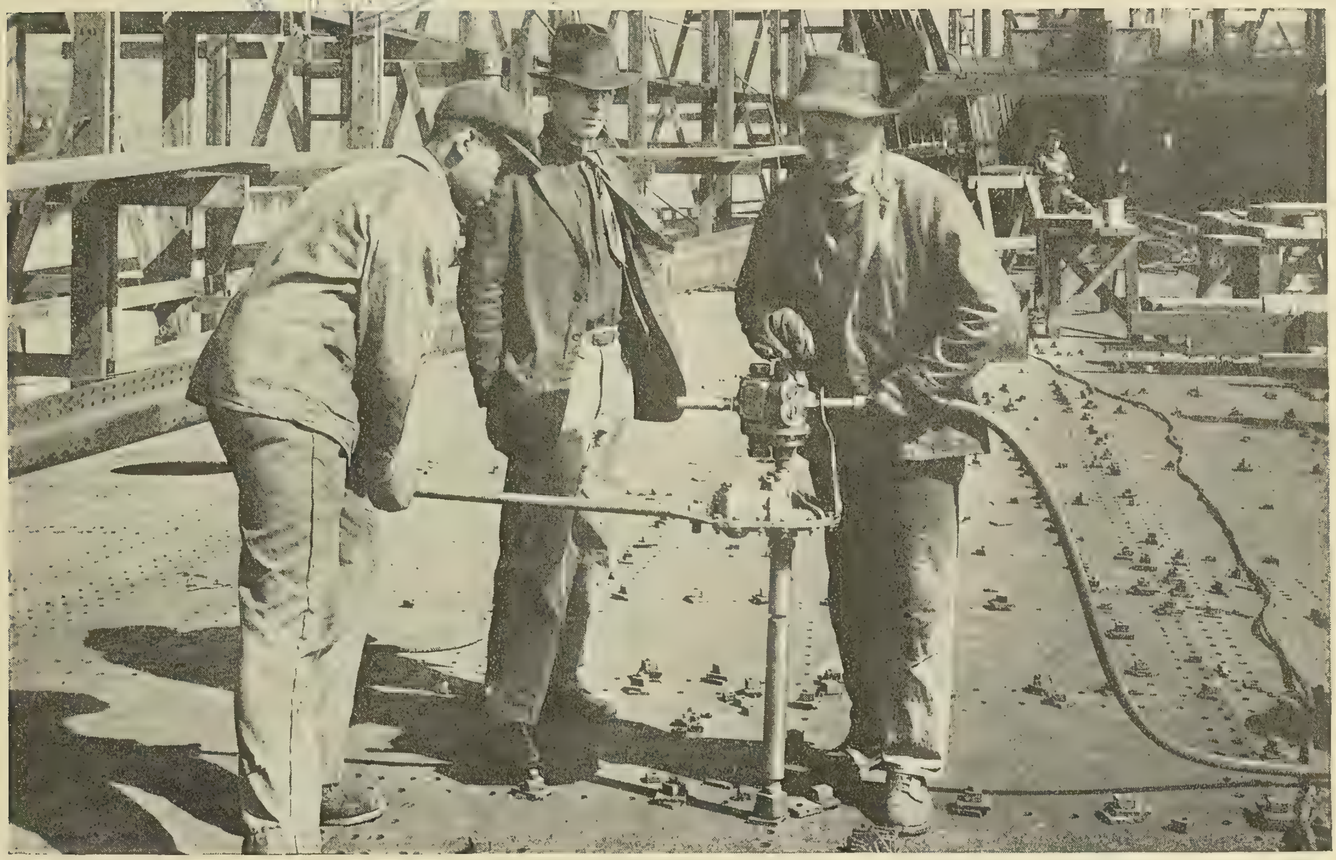


Fig. 1.—"Young" Nut Tightener in Operation

Shipbuilding Economies

Methods Employed at Puget Sound Navy Yard for Reducing the Cost of Ship Construction

BY COMMANDER G. A. BISSET, C. C., U. S. N.

IN its efforts to reduce the cost of shipbuilding during the past three years, the Puget Sound Navy Yard has been able to reduce very appreciably the cost at that yard. While these costs are doubtless considerably higher than at navy yards and shipyards that have had more shipbuilding experience, it is believed that the results of the Puget Sound experience may be of value to others engaged in shipbuilding. With this in view, some of the items that assisted in reducing costs are given below:

Bolting-Up Jacks

One of the shipfitters at the Puget Sound yard, Mr. W. F. Young, who had been in charge of the jacks used in pulling the faying surfaces of plates together, became disgusted with the inefficiency of the hydraulic type of jacks or "plate pullers" he was using and designed the jack shown in Fig. 2. The jack shown in Fig. 2 is a 60-ton jack, but these jacks are made in two sizes, 20-ton and 60-ton. The 20-ton jack weighs about 50 pounds and the 60-ton about 160 pounds.

It has been found that the new type of bolting-up jack, or, as it is more popularly called, "plate puller," operates very satisfactorily, in marked contrast to the hydraulic jacks, which, on account of the high pressure to which the valves were subjected, were constantly out of repair and leaking.

The 20-ton jack has been found suitable for practically all the new construction at this yard, and it has now become almost indispensable in bolting up heavy plating, particularly keel plates, tuck plates and plates near the bow and stern. New uses are constantly being found for the machine. It has been learned that there is a large field of usefulness for it in straightening out bent shapes and plates encountered in repair work, a number of jacks of this type having been used to advantage on a bottom job for the battleship *New York* in straightening out plates and frames. Fig. 3 shows the jack in use for removing dents in shell plates. The jack can be completely disassembled and reassembled in about five minutes, this feature being important, as little time is lost in case a bolt is broken and has to be replaced. Fig. 4 shows the jack disassembled.

The heavier type of jack, viz., the 60-ton, was developed to take care of any work liable to be encountered in the yard, it being assumed that it would be useful particularly for bolting up special treatment steel plates.

While Mr. Young has obtained a patent on the above device as well as upon the nut tightener described below, the United States navy yards are permitted to manufacture and use them without paying royalty. The Puget Sound yard, with 2,300 employees in the hull division, has for several months had continual use for six of the 20-ton jacks, and the demand for the jack is such that it is proposed to manufacture more 20-ton jacks and probably three 60-ton jacks. These jacks cost about $95 each for the 20-ton and $325 each for the 60-ton.

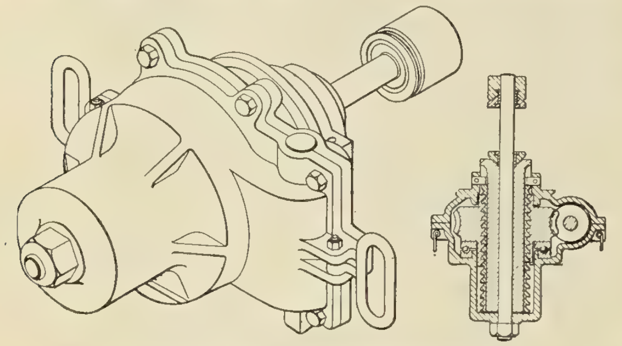


Fig. 2.—"Young" Bolting-Up Jack

Nut Tightener

The nut tightener shown in Fig. 5 and Fig. 6 is used for bolting up on new construction work. While it is not considered that this device is as indispensable as the jack, it is nevertheless very useful, and it is believed that by its use great saving can be effected in the bolting up of a ship. In the endeavor to keep down the weight of the machine to the minimum, the one shown in the figure is somewhat too light, so that it is now out of repair more than it should be. The machine is being re-designed, however, to give additional strength. A suitable stock of these machines for the erection of a 10,000-ton vessel would be about six. Fig. 1 shows the machine in use.

Fig. 3.—Bolting-Up Jack Removing Dent from Ship Plate

Oxy-Acetylene Cutting

Fig. 7 shows the torch tip used for oxy-acetylene cutting at the Puget Sound Navy Yard, this tip being much more economical than that furnished by the manufacturer with the cutting torches. The ratio of oxygen and acetylene used is believed to be about as follows: Standard tip to Puget Sound tip as two to one for both oxygen and acety-

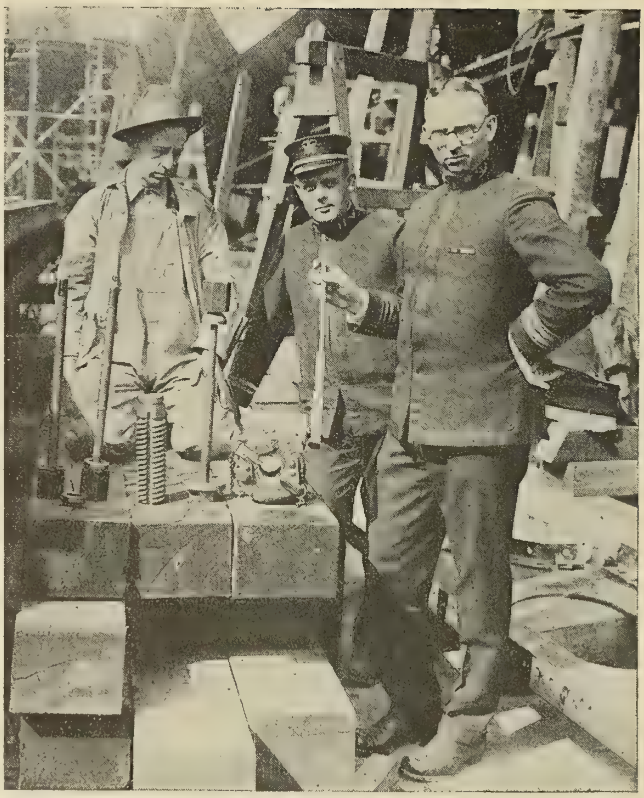


Fig. 4.—Bolting-Up Jack Disassembled. Time Required to Disassemble About One Minute

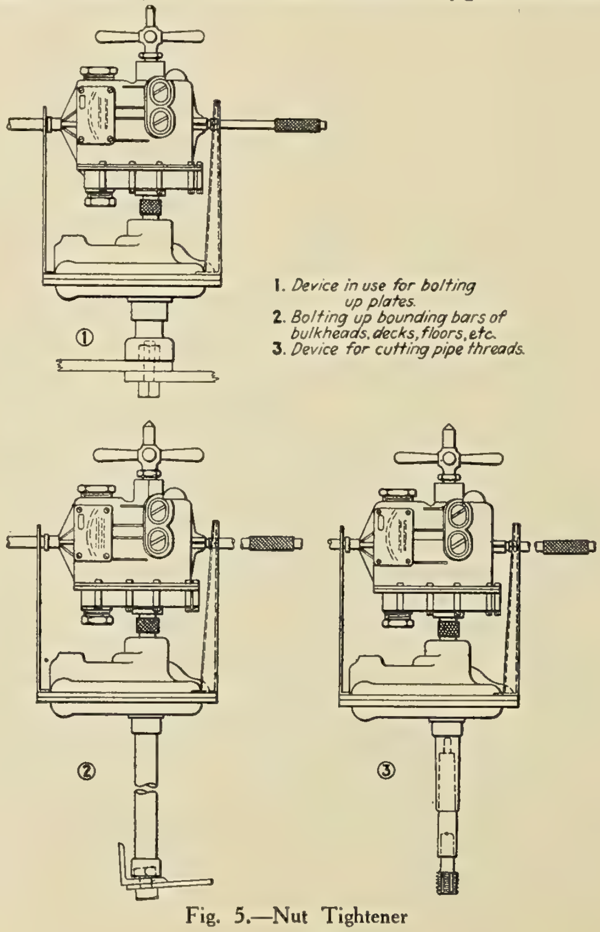


Fig. 5.—Nut Tightener

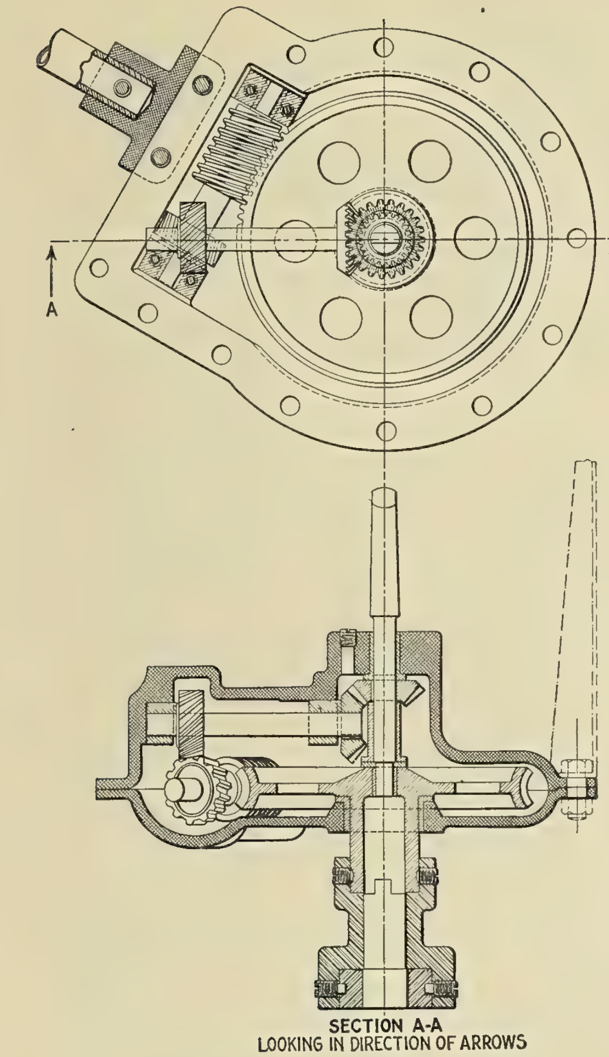


Fig. 6.—Details of Nut Tightener

lene. This torch can also be used for hydrogen, thereby making unnecessary the purchase of a *special hydrogen* torch at a cost of about $70.

The saving in oxygen and acetylene made by this torch appears to be due mainly to the more thorough mixing of the gases. A very appreciable saving in labor is likewise effected by this torch for the reason that it cuts more quickly than other designs, the improved torch cutting about 30 percent faster than the usual type.

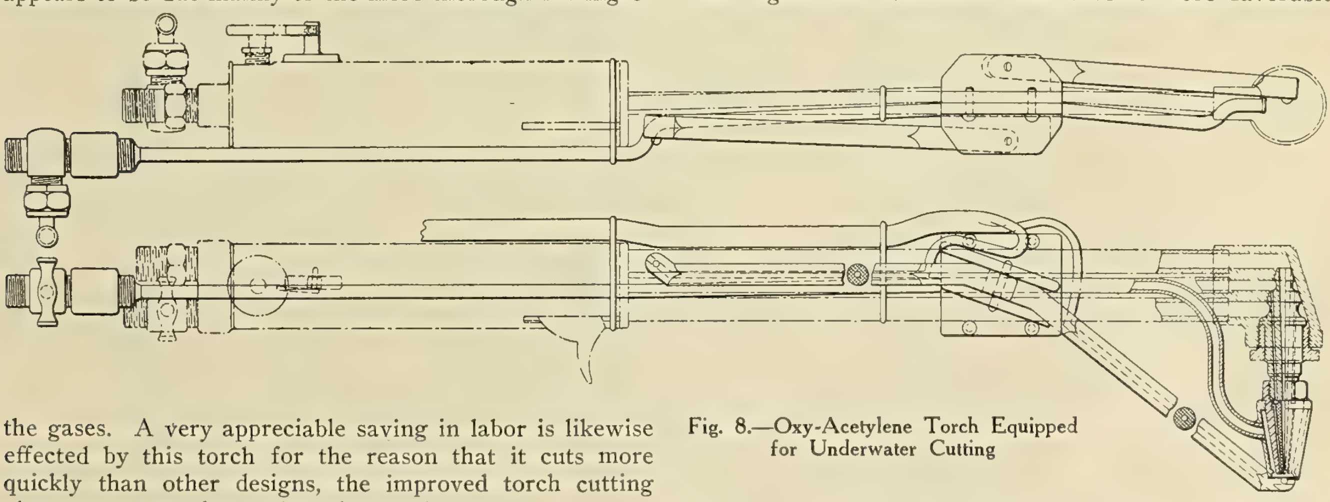


Fig. 8.—Oxy-Acetylene Torch Equipped for Underwater Cutting

Oxy-Acetylene Cutting Under Water

While occasions for use of an oxy-acetylene cutting device during the construction periods of a vessel are very rare, the fact that the tip shown in Fig. 7 is adaptable for such work is considered to be of interest to many readers of this magazine. It will be readily apparent that such a device would be very valuable for salvaging material from sunken vessels.

The device, as equipped for submarine cutting, is shown in Fig. 8. An air jacket attached to the tip is supplied by a pipe with air compressed at a pressure of 100 pounds. Small lugs prevent the tip from touching the metal and extinguishing the flame, and the annular jet of air under the above pressure will effectually protect the flame at depths to about 200 feet without adjusting. An electrical device is used to light the torch under water, thus effecting a saving in gases, as the diver can extinguish and relight the torch as the work requires.

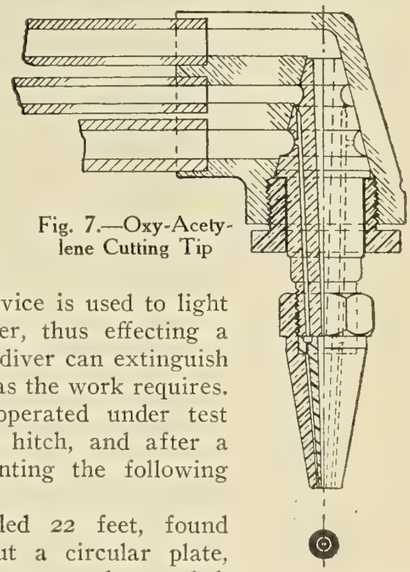


Fig. 7.—Oxy-Acetylene Cutting Tip

This device was operated under test without the slightest hitch, and after a few hours' experimenting the following record was made:

The diver descended 22 feet, found the steel and cut out a circular plate, retrieved the piece cut out and ascended, all in six minutes, the length of cut being 19 inches in 20-pound plate, oxygen at 65 pounds and acetylene at 24 pounds. Steel plating 1 inch thick was also cut at the rate of 6 inches per minute.

Riveting

Perhaps the most important single labor item in the construction of a vessel is the riveting. A vessel of 10,000 tons displacement of the type of the ammunition ships built at the Puget Sound yard has about 1,200,000 rivets in its structure, exclusive of the rivets in manholes, doors, skylights, hatch covers and similar items. The labor cost of the 1,200,000 rivets in ammunition ship *No.* 1, which was built during war times when overtime was being worked and farmers were being taught to drive rivets, was about 13⅓ cents each. Ammunition ship *No.* 2, which was begun after conditions had become more favorable, was built at a labor cost per rivet about one-third less than *No.* 1, while the *Medusa,* now under construction, cost about two-thirds less—that is, about one-third as much as ammunition ship *No.* 1.

While the costs were admittedly excessive originally and while the costs at present are not exceedingly low, it is

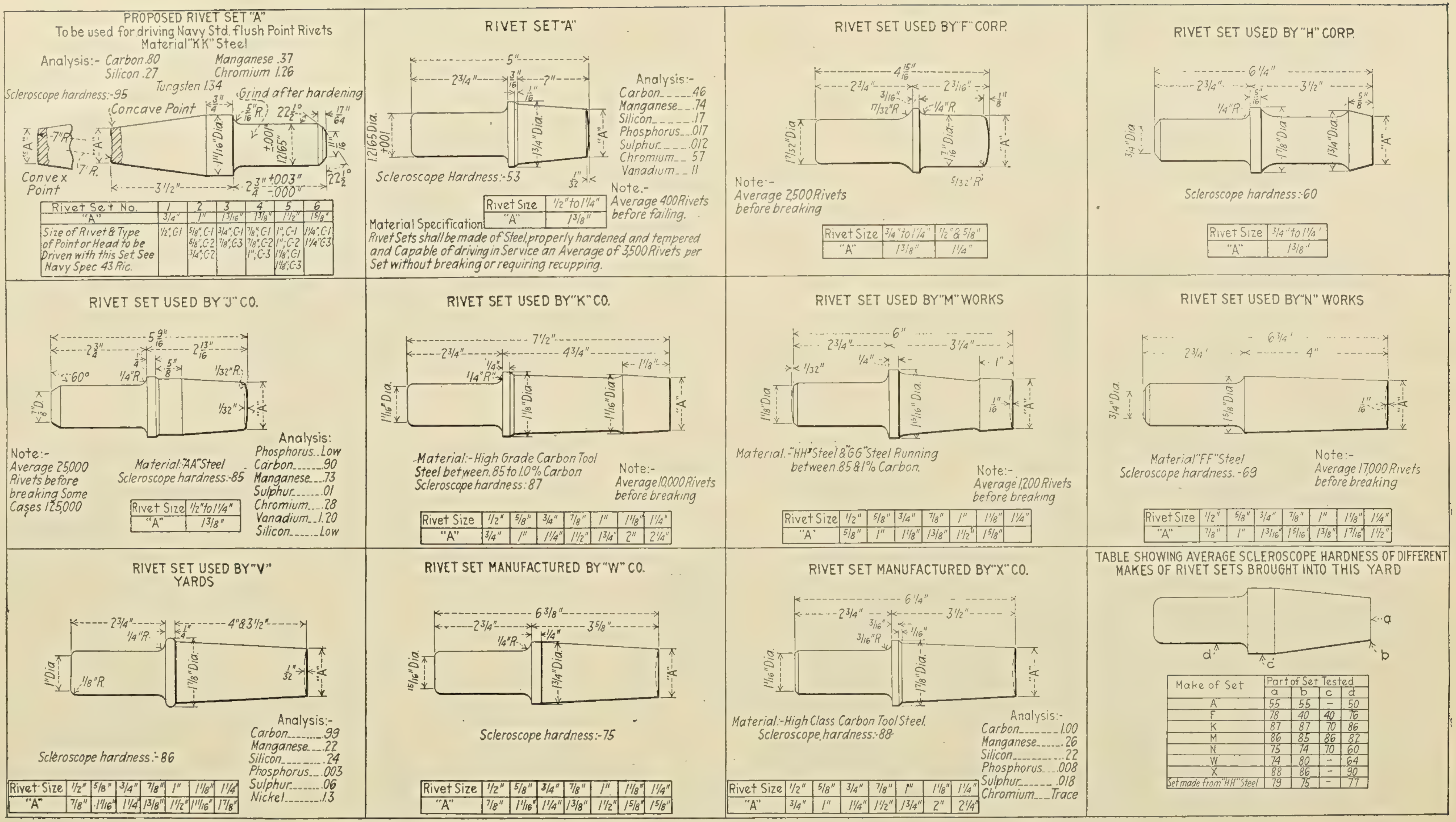


Fig. 9.—Flush Rivet Sets Used by Various Shipbuilding Firms in the United States for Driving Flush Point Rivets

Fig. 10.—TABLE SHOWING FLUSH RIVET SETS DATA FURNISHED BY VARIOUS SHIPBUILDING FIRMS OF THE UNITED STATES

Name of Shipbuilding Firm		"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"I"	"J"	"K"
Ships Delivered to U. S. Shipping Board First 11 Months 1918.	No. of Ships		15	7	4	7	7	2	6	7	4	87
	Total Tons Displacement		118300	31350	40805	51100	61250	19940	58300	46000	34500	305425
Diameter of Point of Rivet Set For Following Size Rivets	1/2" 5/8" 3/4" 7/8" 1" 1 1/8" 1 1/4"	1 3/8"	1" 1 3/8"	1 1/4" 1 3/8"	3/4" 1 1/4" 1 1/2"	.... 1 1/8" 1 3/8" 1 1/2"	1 1/4" 1 1/8"	1" 1" 1 3/16" 1 1/8" 1 1/2" 1 5/8" 1 3/4"	.... 1 3/8"	1 13/16" 1 3/8"	1 3/8"	3/4" 1" 1 1/4" 1 1/2" 1 3/4' 2" 2 1/4"
Length of set outside of gun		2 1/4"	2 1/4"	4"	2"	3 1/4"	2 1/4"	3"	3 1/2"	2 1/4"	2 13/16"	4 3/4"
Shape of Point of rivet set		Convex	1/64" convex edge slightly rounded	Flat	Flat, sometimes concave	Concave	Convex	Concave	Flat or slightly Concave. Never convex	1/32" to 1/16" convex	Flat or slightly convex edge rounded 1/32"	1/2" to 3/4" flat 7/8" to 1 1/4" concave.
Rivets driven per grinding		Not ground	Very seldom ground. Break before dulling	800	100 to 200	500	2 months	2 sets for 2 weeks	1500	Ground only once	1500 to 20,000 Sets rarely upset	Grind every 24 hours
Use of set for calking		Not with set	Not with set	Not with set	Not with set	Calk with set	Not with set	Not with set	Calk with set	Not with set	Not with set	Calk with set
Total rivets driven per set broken at shank		106	700 to 7000	1400	1200 to 1500	1000	100	5000 to 5500 with 2 sets	3000	10000	Approach 25000	10000
Average life of set		400	3 hours to 3 years	1400	1800	2000	2500	No definite record, many 2 years		Two months	Approach 25000 rivets. Some cases over 125,000	6 months
Kind of steel of which set is made and heat treatment given it		Sets are purchased	"BB" tool steel 3 1/2 temper. Preheat slowly to 1300° F. Heat in lead bath 15 min. to 1440° F. Quench in brine 70° F. until cold. Draw in oil 1 hr 450° F. Cool slowly	"CC2" tough. Heated to 1400° F. Quench in fresh water. Draw in oil at 450° F.	"FF" standard No. 3 tempered steel. Heat to 1500° F. Cool in salt water. Draw to 450° F.	Sets are purchased	"CC1"—xcl Harden at 1400° F. Draw in oil to 375° F. for 5 minutes	"CC3"-xx. heated to 1485° F. Quenched in water Drawn in Houghton's tempering oil 475°F. to 485° F. Cool in air.	Own design	"DD" extra steel "EE" steel Co.	"AA" tempered Vanadium tool steel, pat'd heat treatment	Sets are purchased
Cause of failure of set		Break at shank. Soft and cannot be hardened	Pointed pistons, peening action on end of shank. Fracture at shank	Using set until it becomes hot. Then cooling in water.	Fracture at shank	Fracture at shank	Shanks split due to pointed pistons	Allowing set to get too hot. Improper heat treatment	Due to splitting at the shank	Shanks split due to grinding end of piston	Fracture at the jointure of shank and body of set	Poor steel or poor tempering

Name of Shipbuilding Firm		"L"	"M"	"N"	"O"	"P"	"Q"	"R"	"S"	"T"	"U"	"Y"
Ships delivered to U. S. Shipping Board first 11 months 1918.	No. of Ships	12	34	11	8	2	7	2	17	9	10	9
	Total tons Displacement	41200	116200	35080	70400	11000	25500	17600	188525	84600	88000	28500
Diameter of Point of Rivet Set For Following Size Rivets	1/2" 5/8" 3/4" 7/8" 1" 1 1/8" 1 1/4"	15/16" 1 1/16" 1 3/16" 1 5/16" 1 7/16" 1 9/16"	5/8" 1" 1 1/8" 1 3/8" 1 1/2" 1 5/8"	7/8" 1" 1 3/16" 1 5/16" 1 3/8" 1 7/16" 1 1/2"	7/8" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 5/8" 1 3/4"	1" 1 1/8" 1 1/4" 1 1/2" 1 5/8" 1 3/4"	7/8" 1" 1 3/16" 1 5/16" & 1 3/8" 1 9/16" 1 3/4" 1 7/8"	1" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 5/8" 1 3/4"	7/8" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 5/8" 1 3/4"	1" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 5/8" 1 3/4"	1" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 5/8" 1 3/4"	7/8" 1" 1 1/4" 1 3/8" 1 1/2" ....
Length of set outside of gun		4"	3 1/4"	4"	3 1/2"	3 1/4"	3 3/4"	4 1/8"	4"	3 1/2"	3 1/2"	3 1/4"
Shape of point of rivet set		3/32" Concave	1/16" Concave	1/16" Concave	3/16" Concave	Concave	Concave	Concave	Concave	Concave	Concave	Concave
Rivets driven per grinding		200—1" Rivets 500—7/8" Rivets	500	400	25 to 50		100 to 400		500	45	100	25
Use of set for calking		Draws in edge	Calk with set	Draws in edge	Not with set	Calk with set	Calk with set	Calk with set	Calk with set	Calk with set	Calk with set	Not with set
Total rivets driven per set broken at shank		No record	No record	Very few break at shank	75 to 100	500	500 to 3000		4000	No record	200	
Average life of set		10000	12000	17000 to 20000	400 to 600	No record	5000 to 7000	3000	4000	5000	6 months to 1 year	No record
Kind of steel of which set is made and heat treatment given it		"FF" tool steel. Heat to dark cherry red. Quench in water. Draw to light blue	"GG" or "HH" Heated at 1200° F. to 1300° F. Drawn at 450° F.	"FF" No. 3 temper. st'd. tool steel heated 100° F. put in lime. Heated 1450° F. Quenched in water Drawn 400° F. Dipped in black tempering oil.	Sets are purchased	Sets are purchased	"HH" special grade No. 7 tool steel annealed heat 1420° F. Quench in salt water 520° F. Cool in air.	0.80% carbon tool steel and vanadium tool steel	"CC4" xxx tool steel 1% carbon. Heat 1300° F, Quench in water. Temper in oil. Draw to 300° F.	"GG" steel. Tempered by Wheeler process	Heat in gas furnace to 1200° F. Quench in warm water	Sets are purchased
Cause of failure of set		Tool marks or water cracks leading to fracture	Poor steel, Machining and hardening tool marks.	Cannot complain of a common cause.	Too soft	Poor steel	Break at shank. Not finished properly. Tool marks.		Crystalization	Poor steel, tool marks	Temper too hard. Gun socket worn	Improper heat treatment

believed that other yards, by applying the lessons learned, may be able to reduce their costs regardless of what they are at present.

In this connection it seems pertinent to discuss piece work riveting as compared with day work riveting. At yards where the conditions are similar to those existing at present in the Puget Sound yard, viz., with not enough riveting work ahead to employ many riveters, it is undesirable to use piece work riveting. There are now only about fourteen gangs used on new construction, and if piece work were used a smaller number of gangs would doubtless drive the same number of rivets as at present.

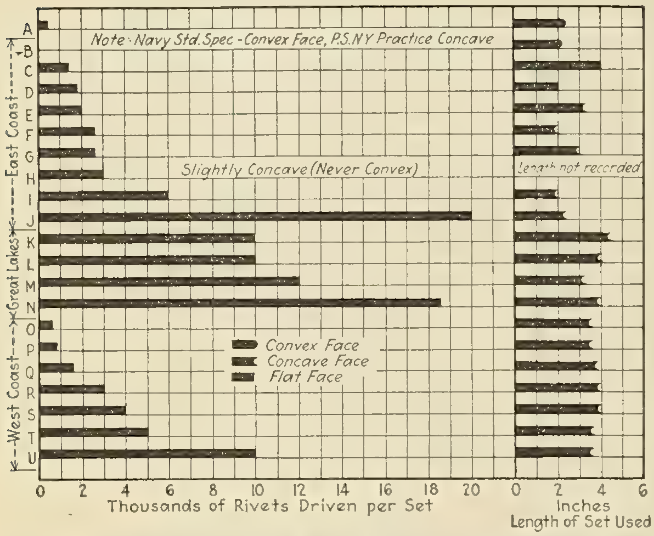


Fig. 11.—Comparative Chart Showing Average Rivets Driven Per Set in 21 Leading American Shipyards; Also Showing Lengths of the Three Sets in Use

With delay in the delivery of structural steel, the work cannot be prepared for the riveter fast enough to make it possible to drive more than about the number of rivets now driven by the fourteen gangs. The use of piece work would, therefore, mean the discharge of some of our riveters and consequently the unavailability of these riveters for *urgent repair work,* availability of men for repair work being the excuse for the existence of navy yards. The introduction of piece work at this yard would also undoubtedly mean an increase in the labor cost of the rivets, as only those that would drive more than an ordinary day's work would do piece work, while the others would drive rivets on day work.

At private shipyards, where all the considerations that enter into overhead expense must be borne in mind, it is believed that any other system than piece work is out of the question. To show why any other system is out of the question it is necessary to make some assumptions. Assume, therefore, that a $2,000,000 vessel is being constructed; that a limited number of good riveters are available for work on the vessel, say fifteen; that these men doing piece work can drive 50 percent more than by day work, and that their output is correspondingly increased from, say, 300 rivets per gang per day to 450. Assume, also, that there are 1,200,000 rivets in the vessel.

On the above assumptions it will take 267 days to drive the rivets by day work and 178 days by piece work. It is clear, therefore, that by doing piece work the construction of the vessel would be shortened 89 days, which means that an amount of money representing the value of the vessel, viz., $2,000,000, would be tied up for 89 days less if piece work were used. The interest on $2,000,000 at 6 percent for this number of days amounts to $30,000. While this is not the only saving due to piece work, it probably represents the most important item.

In beginning the study of riveting it is evident that the subject naturally divides itself into two parts, viz., material and personnel—in other words, "the tools" and "the men." As the personnel question tends to settle itself, particularly when piece work is used, the discussion below will consider tools exclusively, except in a number of cases where the morale of the personnel is affected by the tools. Under material will be included also methods and processes.

Rivet Sets

The most important item under material is, of course, the riveting gun, and the part of the gun capable of the most development is the rivet set. While not, strictly speaking, a part of the riveting gun, the set is a part of the rivet driving apparatus.

While investigating rivet sets, twenty-one shipbuilding firms in the United States were interrogated, these firms representing geographically practically all shipbuilding sections of the country. In tabulating replies from the different shipyards, the results being shown in Figs. 9, 10 and 11, the first surprising fact that became evident was that the use of rivet sets with convex points was restricted to the east coast, while all the west coast and Great Lakes yards, and even some of the east coast yards, use rivet sets with concave points. When the concave point is used the concavity amounts to about 1/32 inch. Instead of rounding the edge of the set it is left sharp, so that it can be used to cut off the surplus metal remaining after the rivet holes and countersink are completely filled. This edge is also used to finish off and calk the rivet in a single operation.

It was found also, moreover, that of the twenty-one shipbuilding plants interrogated, not more than three of these plants use a single standard diameter of point of set, 1⅜ inches being the diameter used when only one size is employed. When the convex point is used the diameter of the set may be maintained 1⅜ inches. Where concave points are used, however, it is necessary to have the diameter of the point of the set equal to or slightly smaller than the diameter of the countersink. This necessitates the use of sets with points of several different dimensions, the variation between the diameter of the rivet and the diameter of the point of the set being from ¼ inch to 9/16 inch. The variation in the size of sets used by various shipbuilding firms is illustrated by Figs. 9 and 10.

An absolutely flush rivet cannot be driven with a concave set, and for that reason it is not as suitable as the convex set for driving rivets in decks, if the deck is to be planked or covered in any way. Although a sound, watertight rivet can be driven with either type of rivet set, it has been found in practice that the concave sets drive rivets equally as good in quality and of a much neater appearance than can be driven with the convex type. The concave set drives the rivet, removes all excess metal and calks the rivet in one operation. However, the point of the rivet is liable to be a little high in the center, due to the concavity of the set, and if an absolutely flush rivet is required, the point may have to be chipped off a little. This objectionable feature is being reduced by a tendency to flatten out the concavity of the set. Doubtless, eventually, the west coast yards will use a rivet set with a flat point, the essential feature being that the edge will be kept sharp, with no rounding, in order that the excess metal of the rivet may be cut off without using an extra tool. This will also obviate an objection that has been raised, though not observed at this yard, that the concave pointed sets mar the plating around the point of the rivet.

If all the rivet holes were fair and countersinks uniform in depth, rivets of suitable length could be selected so that the hole and countersink would be completely filled, and at the same time no surplus metal would be left to be disposed of. The convex set would then be satisfactory for all classes of flush riveting and the work of such a nature that the calking of most of the rivets could be dispensed with. It would also require less skill to perform satisfactory riveting, although it is somewhat harder on the riveter to hold the convex pointed set on the rivet. However, the holes and the countersinks are never of uniform size, which is mainly the result of reaming, necessitated by the structure not lining up properly. It is difficult, if not impossible, to select a rivet of the exact length required for each individual hole. As a result, the rivets selected are a little long to insure sufficient rivet stock to fill unfair holes that have been reamed and recountersunk. This leaves a certain amount of excess metal which must be removed either with a chisel or with the sharp edge of the rivet set.

In driving with a convex set, the riveter is either equipped with a chipping gun or with a chisel to fit his riveting gun. After the rivet has been upset and worked into the hole and the excess metal, if any, worked to one side, the riveter either places a chisel in his riveting gun or uses a chipping gun, as the case may be, to remove this excess metal. He then takes up his riveting gun again and goes over the rivet to finish it. On deck riveting the change from riveting gun to chipping gun and vice versa can be made easily and quickly, as the tools can be placed near the work. On shell riveting, however, the tools must be placed on some sort of stand or hung on a hook. In changing from one tool to another, therefore, considerable time is lost, and in addition to this a riveter working on the shell frequently drops his tools or they may roll off the stage plank on account of the vibration due to the riveting. This delays the riveting until the tools are recovered, which requires considerable time and involves an accident hazard for those working below.

It was ascertained at this yard that the type of rivet set designed exclusively for use as a convex set would not give satisfactory service, if ground concave. In using, for instance, the set "*A*" shown near the left hand upper corner of Fig. 9 as a concave set the following objections were observed:

(1) The body of the set is too short to provide a good grip for the operator to hold the set, it being only 2¼ inches long.

(2) Due to the shortness of the set, the riveter's hand is brought so near the hot rivet that his glove is soon burned through and his hand consequently liable to injury. This not only causes suffering and inconvenience on his part, but decreases his efficiency to a considerable extent on account of the precautions he will naturally take.

(3) The riveter's "boot" and glove cover the work to such an extent that it is extremely difficult to see what he is doing.

(4) It is impossible to drive properly a rivet with a short set when the rivet is near the bosom of an angle or close to service bolts and similar obstructions, for the reason that the barrel of the riveting gun, which is approximately 2½ inches in diameter, comes in contact with these obstructions, prohibiting the rolling motion of the gun which is necessary to finish the rivet.

(5) Fig. 10 shows that the average number of rivets driven per grinding with the flat point, or concave point, sets runs up as high as 1,500, while at this yard the corresponding figure was about 60.

(6) The scleroscope hardness of the set, viz., 53, is much too low for a satisfactory concave pointed set. The hardness should range between 75 and 95.

(7) The chemical analysis of the material from which this set is made is as follows:

Carbon	.46	Sulphur	.012
Manganese	.74	Vanadium	.11
Silicon	.17	Chromium	.57
Phosphorus	.017		

Steel of this chemical content shows little response to heat treatment, and it appears impracticable to give it a treatment that will make it satisfactory for use in concave sets.

(8) The collar shown just below the fillet of the shank of the set is undesirable. As the sets are turned from bar stock it is apparent that where the collar is required the waste material is considerably greater than where the collar is omitted. Moreover, where the collar is present satisfactory heat treating is more difficult, particularly where there is a sharp angle below the collar. It has been

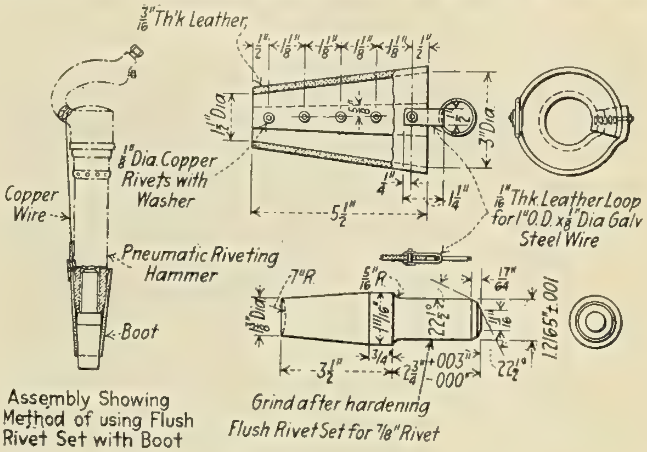


Fig. 12.—Flush Rivet Set and Boot

found that frequently, while the set is in use, the collar will chip off, damaging the set and the riveting gun. The collar was used in connection with a clip that held the rivet set in the gun. This clip was larger in diameter than the barrel of the gun, being too large to permit the operator to close his hand tightly around the set. The clip, moreover, bore on a small area in the palm of the hand in such a way as to make the palm sore in a short time. After some experimenting the type of "boot" shown in Fig. 12, which is made of chrome leather and held in place with copper wire, was found to give much better results. With this "boot" the riveter can encircle the set completely with his hand and consequently has the set in much better control than formerly.

(9) The upper end of the shank has the corners rounded off to a radius of ⅛ inch only. A radius of 5/16 inch should be used instead, or preferably two conical surfaces as shown in Fig. 12, the conical surfaces constituting a smaller machining operation than the rounded surfaces. The net result is the same, viz., that the diameter of the point of the shank upon which the piston impinges is 11/16 inch, the same as the diameter of the point of the piston. This not only prevents the piston and the set from indenting each other, but also prevents upsetting the end of the shank and causing the edges to chip off or expand and jam in the barrel of the gun. This rounding also facilitates the exhausting of air ahead of the piston on the down stroke and likewise facilitates the entry of the air to force the piston back on the return stroke. In this way the piston is given a greater speed, which shortens the operation of driving the rivet.

(10) The fillet at the juncture of the shank and body is 3/16 inch in this set. This radius should be 5/16 inch to make it correspond with the radius of the inner lip of the riveting gun barrel. When these dimensions are the

Fig. 13.—Riveting Between Service Bolts With Present Navy Standard Type E Rivet Set, Showing Difficulty of Using Short Set and Liability of Injuring Operator's Hand

Fig. 14.—Riveting Between Service Bolts With Proposed Standard Set, Showing Ease With Which Set is Used. Rivet Being Driven Straight Down to Swell the Shank of Rivet and Fill Hole

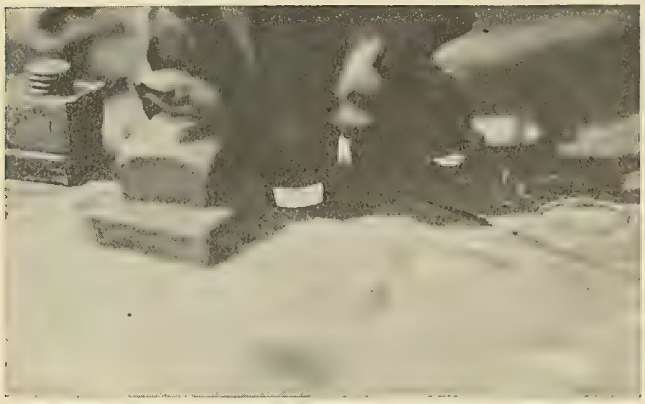


Fig. 15.—First Operation in Driving a Flush Rivet, Showing Rivet Being Driven Straight Down to Swell the Shank of the Rivet and Fill the Hole

Fig. 16.—Driving Straight Down With Proposed Standard Set to Swell Rivet Shank and Fill Hole

Fig. 17.—Rivet in Center Foreground Partially Driven, Showing That Rivet is Driven Straight Down With Concave Set to Swell Shank and Completely Fill Hole. Metal Expanded Equally in All Directions. Rivet is Still to Be Driven Securely Into Countersink, Calked and Excess Material Removed

Fig. 18.—Calking and Removing Excess Material from Rivet With Proposed Standard Set

same, the set fits snugly in the end of the gun and consequently is much more easily handled by the riveter. Moreover, with the larger radius of the fillet the liability of developing internal stresses during the heat treating process is minimized.

(11) Where the set is so short the heat from the rivet causes the shank to expand with danger of jamming in the barrel of the gun. Unless longer sets are used it is necessary to change the sets often to permit them to cool off.

(16) While heretofore a rivet set driving 3,500 rivets before failure was considered satisfactory, it has been found practicable to obtain sets that will drive easily from 12,000 to 18,000 rivets before failure. They can also be so heat treated as to drive at least 400 rivets without regrinding. It is desirable that a rivet set be able to drive all the rivets a man can drive in eight hours without regrinding, so that no delay will be caused during the day by sending the set back to the grinder.

(17) Steel showing chemical content as follows has been found to give excellent results when made up into rivet sets, the set used being the design shown in Fig. 9 as the proposed standard *"A."*

Carbon	.80	Manganese	.37
Silicon	.27	Chromium	1.26
Tungsten	1.34		

The heat treatment of this steel consists merely of quenching in oil from 1,750 degrees F., the temper not being drawn at all.

Fig. 19.—Removing Excess Material During Calking Operation

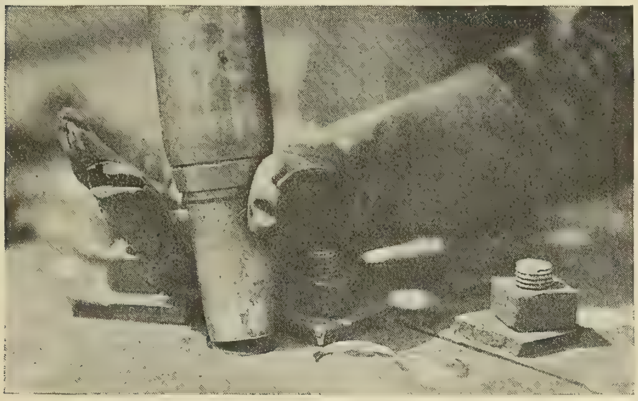


Fig. 20.—Calking Finished Rivet While Still Hot

Fig. 21.—View Showing Rivets Driven With Navy Standard and Proposed Rivet Set, Showing Rivets Tightly Calked With Proposed Set But Loosely Calked With Standard Set

(18) While tests were conducted at this yard to ascertain which type of set as between the convex and the concave could drive rivets at the lower cost, it is considered that the tests were hardly fair to the convex sets in view of the greater familiarity of the west coast riveters with the concave set. It was found that where the points of the rivets have to be calked the concave set is much preferable, the calking being done while the rivet is still being held on. Unless the rivet is held on while the point is being calked, it is liable to be loosened. It would manifestly be much more expensive to calk the rivet if the calking were performed in an entirely separate operation with a holder-on helping the calker. In the riveting of decks that are to be covered with linoleum or wood decking, however, it is desirable that the convex point sets be used.

It is considered that the proposed set shown in Fig. 9 eliminates all the objections encountered, the set being of the chemical content recommended elsewhere above. While this set is considerably heavier than the lighter set heretofore used, its increased life much more than makes up for the greater first cost. Its greater output at one grinding likewise removes a source of great annoyance. The inertia of the heavier set will, it is believed, result in less vibration of the gun, while its great reliability will prevent the frequent recourse to the tool room, will not afford the riveters excuses for small output, and will better the morale of the working force besides being more popular with the piece workers.

The advantages of the proposed standard rivet set are further illustrated by Figs. 13 to 21 inclusive, which are actual photographs taken from work.

Pistons

It is found that the standard pistons furnished with the 6-inch riveting guns are 3 inches in length. As it was learned that the men were continually removing the standard pistons and using 2½-inch pistons in these guns, the question of the most efficient length of piston was investigated.

While the manufacturers of the riveting gun recommend the 3-inch piston, it was found that with the 2½-inch piston a rivet could be driven in appreciably less time. It is believed that this result is due to the fact that the shorter piston travels further and consequently attains a higher speed at the time it strikes the end of the rivet set. Its momentum is, therefore, greater in proportion to its weight than is the momentum of the heavier piston. On account of its lesser weight, moreover, its inertia is less, so that the return stroke is quicker than in the case of the heavier piston. Increasing the number of strokes naturally reduces the vibration of the gun, very much in the way that the vibration of a steam engine is reduced when three cylinders are used instead of two.

This yard has no facilities for counting the strokes of the hammer with different size pistons, but it is believed that this whole question is one of sufficient importance to warrant the conducting of a series of tests that would give the most efficient length of piston for each size of riveting gun.

Rivet Forges

Electric forges for heating rivets by placing them between electrodes have been tried at a number of places on

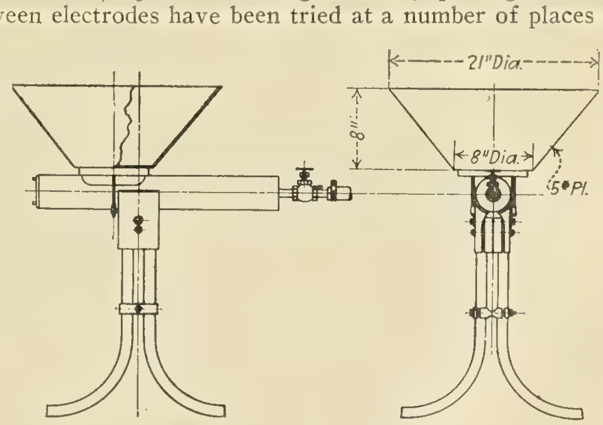


Fig. 22.—Rivet Heating Forge (Coke)

ship work and appear to be unsatisfactory. While electric furnaces have not been tried at this yard, it is believed that the heating cost would be excessive.

Oil forges have possibilities. Unless the oil forges, however, are fitted with a tank sufficient to hold more than a day's requirements of oil, they are unpopular and inefficient. Moreover, more skill is required of the heaters in using oil forges, as otherwise the rivets are liable to be

(*Concluded on page* 907.)

Fig. 1.—S. S. *Panhandle State* Leaving the Builders' Yard

Passenger Accommodations on Shipping Board Steamship Panhandle State

Arrangement of Living Quarters on First Passenger Vessel Completed by an American Yard for the United States Shipping Board

THE steamship *Panhandle State* recently placed in commission in the transatlantic service is the first ship to be completed of a group of seven combined passenger and freight vessels being built by the New York Shipbuilding Corporation at Camden, N. J. The structural features of these ships were fully described in the April, 1920, issue of MARINE ENGINEERING. Some of the principal dimensions are here repeated, as follows:

Length overall	522 feet 5 inches
Length between perpendiculars	502 feet
Beam, molded	62 feet
Depth to "A" deck	42 feet
Draft, summer	32 feet 3 inches
Gross tonnage	10,533
Deadweight tonnage	13,100
Service speed	14 knots
Indicated horsepower	7,000

These vessels have limited passenger accommodations, being fitted up for 78 first class passengers. No second or third class passengers are carried. The staterooms and public rooms are situated on the "A" deck within the bridge, also on the bridge and promenade decks above. They are spacious and luxuriously appointed. The designs for the interior decoration are by W. and J. Sloane, of New York, which firm also supplied some of the furniture.

Staterooms on the Promenade Deck

In the forward end of the promenade deck house there are nine staterooms, each for two persons. These rooms measure 9 feet 3 inches by 8 feet, with 7 feet 3 inches clear headroom, and are finished in white with mahogany trim. They are furnished with two single beds of square metal tubing enameled to harmonize with the finish of the rooms, a mahogany dressing table of pleasing design, a comfortable, upholstered chair, a lavatory and a wardrobe. The floor is carpeted. Four of these rooms communicate with shower bath rooms.

Between the boiler and engine casings there is a spacious lobby at the head of the staircase leading down to the bridge deck. The after end of the house is given over to the smoking room, which is finished in fumed oak, mission style, with a tiled floor and deep beamed ceiling. An electric fireplace occupies the center of the forward side, flanked by upholstered seats. The sides of the room are divided into cozy alcoves.

No air ports are fitted in the promenade deck house, their places being taken by large rectangular windows of novel design, arranged with a narrow stationary upper sash and a large movable lower sash, permitting clear vision at all times by avoiding the obstruction of the old-style meeting rail. A shallow inner frame allows ventilation without drafts when the sash is raised a few inches.

Enclosed Promenade Deck

An enclosed promenade extends the full length of the deck on both sides, 95 feet long and 8 feet wide, the outboard side above the bulwark being fitted with vertical sliding windows of the Laycock type, which may be opened in fair weather. Abaft the house there is an additional open promenade 24 feet square.

Extending across the front of the bridge deck house, with deep wings running aft alongside the boiler casing, is the social hall, finished in white in the Adams design with upholstered mahogany furniture. The floor is carpeted in gray. A stair with gracefully curving balustrades descends to the "A" deck. A feature of the passenger stairways is the elimination of the usual brass nosing and kick plates. The stair risers as well as the treads are rabbeted to receive rubber tiling which presents a flush surface and gives the effect of a carpet runner.

Bridge Deck Staterooms

Ten staterooms, similar to those on the promenade deck, occupy the sides of the bridge deck house abaft the social hall. These rooms are arranged in pairs with shower

Fig. 2.—Smoking Room

Fig. 3.—Dining Room

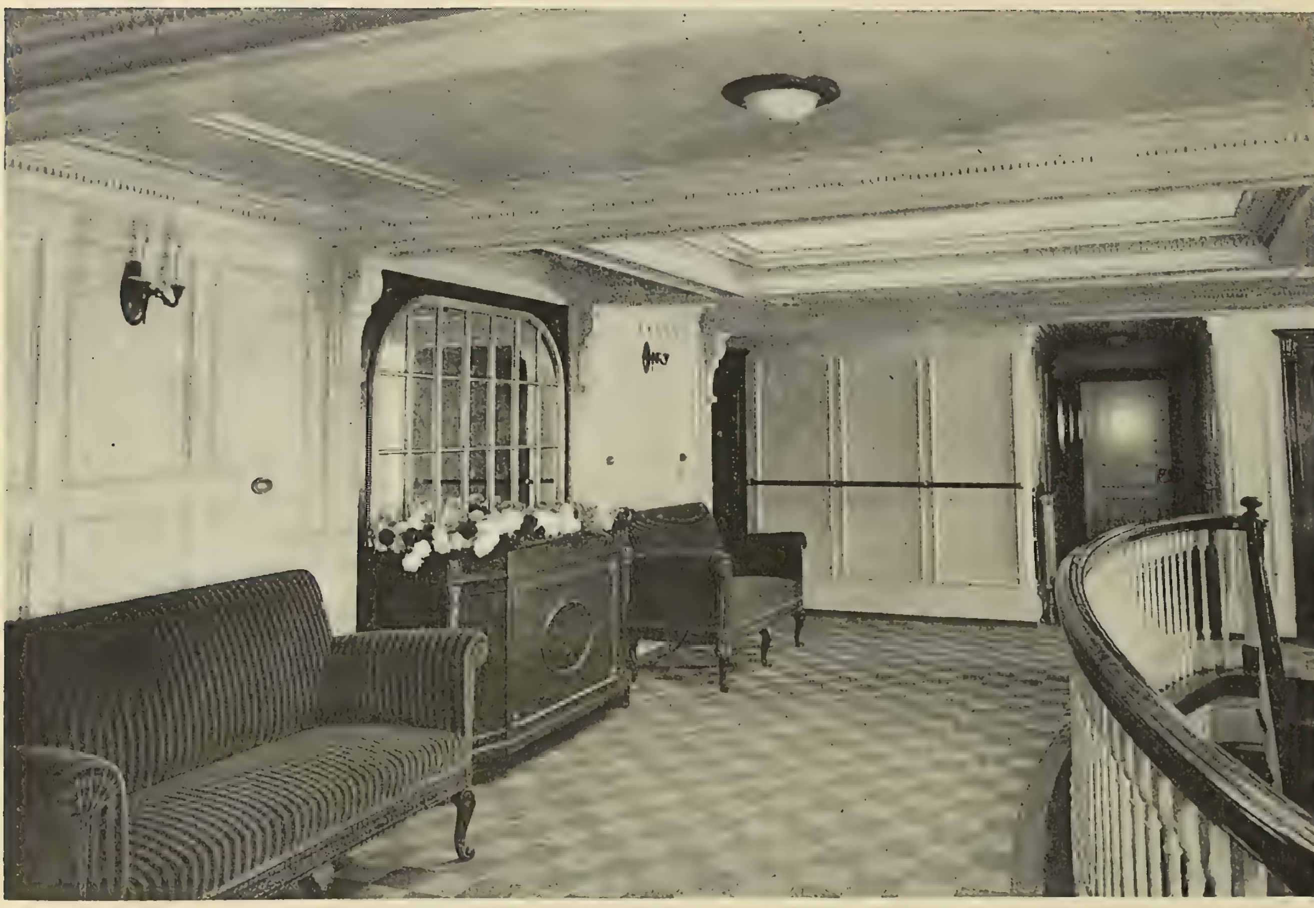


Fig. 4.—Lobby

Fig. 5.—Social Hall

Fig. 6.—Writing Room

Fig. 7.—Stateroom

bath rooms between. A writing room with the conventional tables is located between the boiler and engine casings. Here there is an electric fireplace surmounted by a floral panel piece done in oil. A veranda café, open to the air on one side, faces the promenade at the after end of the deck. The finish is weathered oak in a carved trellis design that carries out the idea of a shaded garden. Between the deck house and the ship's side there is an open promenade 9 feet wide.

It is on the "A" deck, however, that most of the passengers are accommodated, there being twenty staterooms for two passengers each. The greater width available on this deck also permits larger rooms than those in the superstructure. These are 9 feet 6 inches long and 16 feet wide. The finish is white and trimmed with mahogany, uniform in style with the other rooms, but the furniture is a trifle more elaborate, although very simple and neat in design. Sixteen of these rooms have two beds each, one stationary and one folding, a sofa, two built-in wardrobes and two chiffoniers. A bath room is located between each pair of staterooms. Four rooms amidships are fitted up as bridal suites, with baths, and have two stationary beds, a large upholstered sofa and a combined dresser, chiffonier and wardrobe. The doors of these wardrobes have full-length mirrors which can be swung to any desired angle.

Dining Saloon Arrangements

The dining saloon, with seating capacity for all the passengers at one time, is located at the forward end of the bridge on the "A" deck. It is lighted by air ports on three sides, the ports being masked behind glazed sashes of pleasing design. The scheme of finish and furniture here is colonial, in white and mahogany. The pantry is located in close proximity to the dining saloon, over the galley, which is on "B" deck.

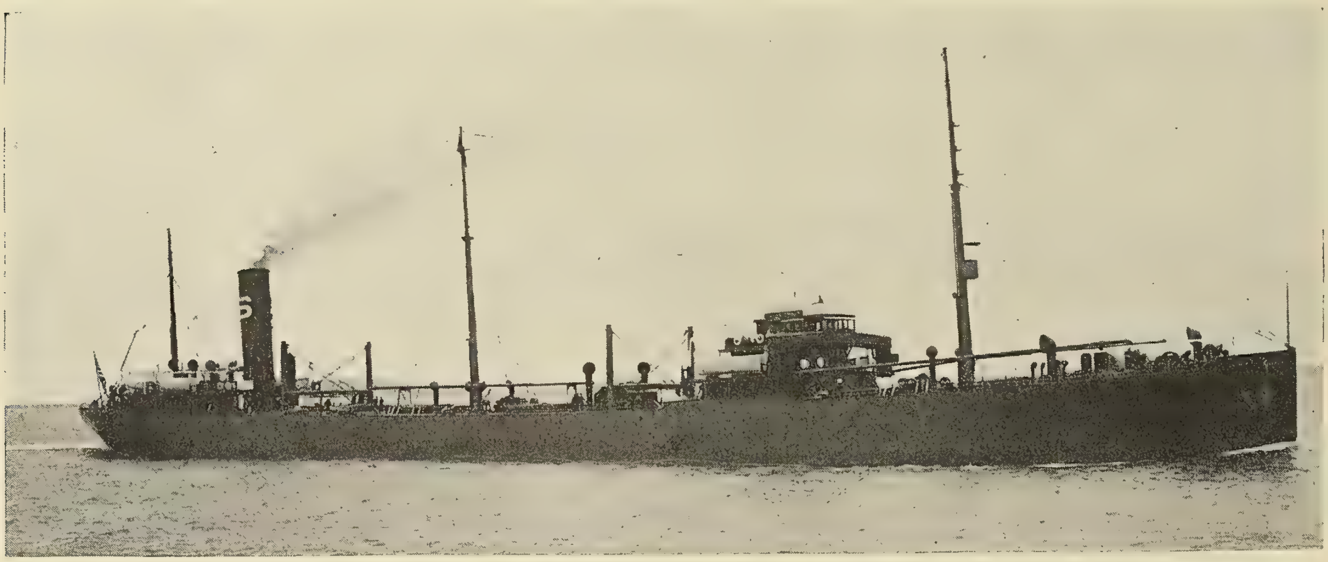
The dining saloon and staterooms on the "A" deck are supplied with heated fresh air by a thermotank system of forced ventilation. Throughout the passenger spaces there are radiators and a profusion of electric fans to insure the comfort of the passengers regardless of the condition of the weather.

The electric lighting fixtures have received special attention and harmonize perfectly with the decorative treatment of the rooms. In short, everything has been done to place these ships on an equal footing with the finest ships in service.

Panhandle State in Service of American Company

The keel of the *Panhandle State* was laid in 1919. The vessel was launched March 9 of this year and the acceptance trials were run August 19. Construction of the vessel was commenced during the war, when it was planned to utilize her as a troopship. While still under construction, however, she was re-designed as a combination passenger and cargo vessel, and for this reason her completion was greatly delayed.

Since leaving the yard at Camden the steamer proceeded to New York, where she took on a full cargo and passengers for her maiden voyage in the New York-Queenstown-Boulogne-London service, to which route she has been assigned under the flag of the United States Mail Steamship Company, New York. The vessel is commanded by Captain C. M. Stone, while the chief engineer is Albert W. Young.



Trial Trip of the *China Arrow*, October 1, 1920

Tank Steamer China Arrow Delivered to Standard Transportation Company

THE Fore River plant of the Bethlehem Shipbuilding Corporation, Quincy, Mass., has just completed for the Standard Transportation Company, New York, the single screw tank steamer *China Arrow*, a shelter deck Isherwood framed vessel 485 feet long, 62 feet 6 inches beam, 39 feet 6 inches depth and about 26 feet 6 inches draft. Propulsion is by a triple expansion, four cylinder, direct acting, surface condensing reciprocating engine with cylinders 24 inches, 35 inches, 51 inches and 75 inches diameter, all with a common stroke of 51 inches. Steam is supplied at a pressure of 220 pounds per square inch by three Scotch boilers each 15 feet 3 inches diameter and 11 feet 6 inches long.

The *China Arrow* is the first of four bulk oil steamers to be constructed for the Standard Transportation Company, of New York, at the Fore River plant. The vessel has a straight stem and elliptical stern with bridge houses amidships and aft around the engine and boiler casings. There are three steel pole masts and ten double main cargo tanks with a combined capacity of 3,665,700 United States gallons.

6,300-Ton Deadweight Freighter

Economical Type of Cargo Steamer Designed by the Baltimore Dry Docks and Ship Building Company

DUE to the slowly dropping freight rates and the keen competition developing in marine transportation, it becomes more and more important to the ship operator to consider the possibilities of economies in operation costs resulting from the properly co-ordinated design of carriers.

With this in mind, the Baltimore Dry Docks and Ship Building Company, Baltimore, Md., has designed and now has under construction a somewhat new type of general cargo steamer combining in one design many of the factors found through long experience by this company to be conducive to the most economical handling and delivery of general cargo. This design will be constructed as a stock ship and is expected to find a ready market on account of its many attractive features.

PRINCIPAL ATTRACTIVE FEATURES

1. Economical propulsion.
2. Large cubic capacity.
3. Maximum tonnage exemption.
4. Large cruising radius.
5. Quick change oil to coal or vice versa.
6. Elaborate cargo handling facilities.
7. Large clear holds of about equal capacity.
8. Arranged for efficient stowage of grain or baled cotton.
9. Mast heights to enter Manchester Canal.
10. Well arranged quarters.
11. Modern design of propelling machinery.
12. Isherwood construction and dual classification.

Classification

Constructed under dual classification, these ships will class ✠ 100-A-1 at Lloyd's Register of Shipping and ✠ A-1 [E] American Bureau of Shipping. The construction and equipment will also be in accordance with the Rules of the United States Supervising Inspectors of Steam Vessels.

Characteristics

The general particulars of these vessels, which will be of the type with machinery located amidships and one funnel, are as follows:

Length overall	356 feet 0 inches
Length between perpendiculars	340 feet 0 inches
Beam, molded	49 feet 0 inches
Depth, molded	28 feet 7½ inches
Load draft	24 feet 9 inches
Total deadweight	6,300 tons
Cubic capacity of all cargo spaces, exclusive of deep tank space, grain measurement	330,000 cubic feet
Fuel oil capacity	1,356 tons
Reserve feed water, double bottom	125 tons
Domestic fresh water	8,000 gallons
Sea speed	10½ knots
Indicated horsepower	2,000

Hull

The vessel will be built on the Isherwood system of longitudinal framing with a straight stem and semi-elliptical stern. It will have one complete steel deck, a short poop 33 feet long, a long bridge 221 feet long and extending over the engine and boiler casings, and a forecastle deck 30 feet long, all of steel construction.

Four steel, watertight, transverse bulkheads and three steel oiltight bulkheads will be fitted.

A cellular double bottom extending the entire length between the peak bulkheads will be fitted for the carriage of fuel oil, except under the engine space, where reserve feed water will be carried.

The fore peak tank will be used for the storage of fuel oil, and the after peak tank for reserve feed water.

Two steel deck houses will be erected on the bridge deck, one in way of the engine and boiler casings and one between No. 2 and 3 hatches, with quarters arranged as shown on the accompanying plans. A steel deck house to accommodate the captain's quarters will be erected on top of the forward bridge deck house, and above this a wooden pilot house will be built. Crew's quarters are provided in the poop.

Two steel masts, with telescopic wooden pole topmasts, and two king posts will be provided. The height of the masts, with topmasts housed, will be such as to enable the vessel to pass under the Manchester Canal bridges in light condition.

All rigging fittings, ventilation, etc., will be fitted in accordance with the best marine practice for a vessel of this type.

The vessel will be equipped with two 28-foot lifeboats located on the boat deck and one 16-foot motorboat located on the port side of the upper bridge.

Cargo Space

The forecastle has been designed for the stowage of cargo and boatswain's stores. The under deck space will be divided into four cargo holds and a deep tank. An oiltight centerline bulkhead will be fitted in the deep tank and provision made for the carriage of fuel oil or cargo. No. 3 'tween decks above the deep tank will also be used as cargo space.

Cargo Handling Gear and Deck Auxiliaries

Five 5-ton wooden or tubular cargo booms will be located at the mainmast and also at the foremast, and one 3-ton wooden cargo boom will be provided at each kingpost. The handling of lines and cargo hoists from the booms will be by means of five steam winches located at each mast and one winch at each kingpost.

A warping winch will be provided aft on the poop deck and a steam windlass forward on the forecastle deck.

Steam steering gear will be installed in the poop with telemotor connection to the pilot house.

Hatches

Access to the deep tank will be provided by two oiltight hatches, one being located each side of the centerline. Large cargo hatches will be located in way of each hold and to the bridge space as shown on the accompanying plans. A small hatch in the forecastle deck will provide access to the boatswain's storeroom, and a steel companionway will be erected on the poop deck for access to the crew's quarters.

Propelling Machinery

The main propelling machinery will consist of one triple expansion engine of the vertical, inverted, surface condensing type having cylinders 23 inches, 39 inches and 65

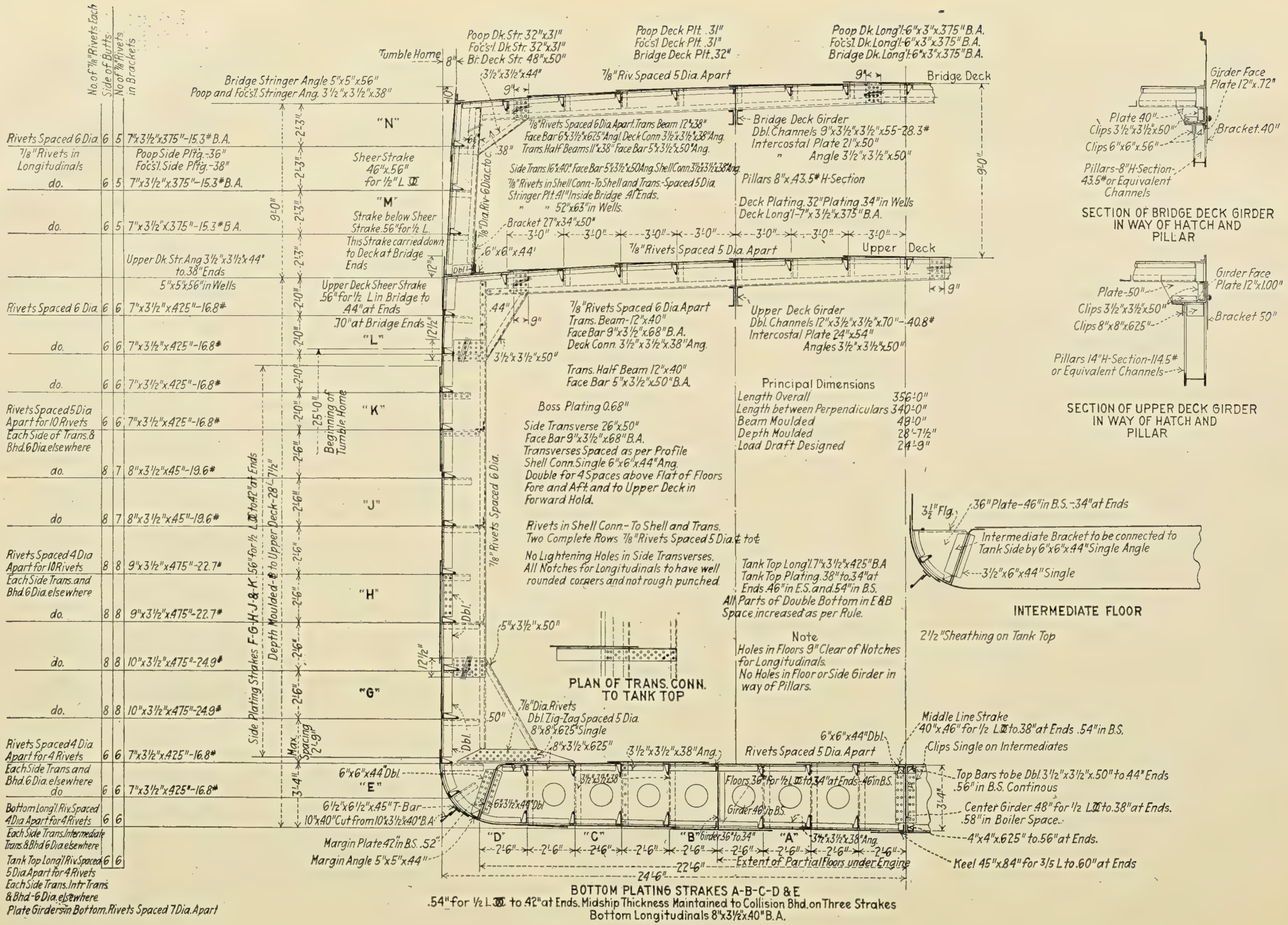
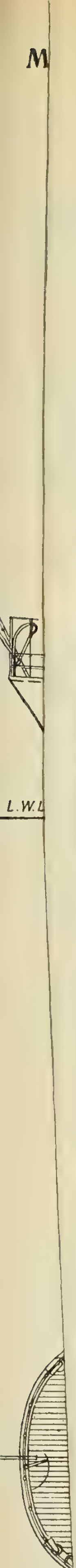


Fig. 1.—Midship Section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6,300-TON DEADWEIGHT FREIGHTER

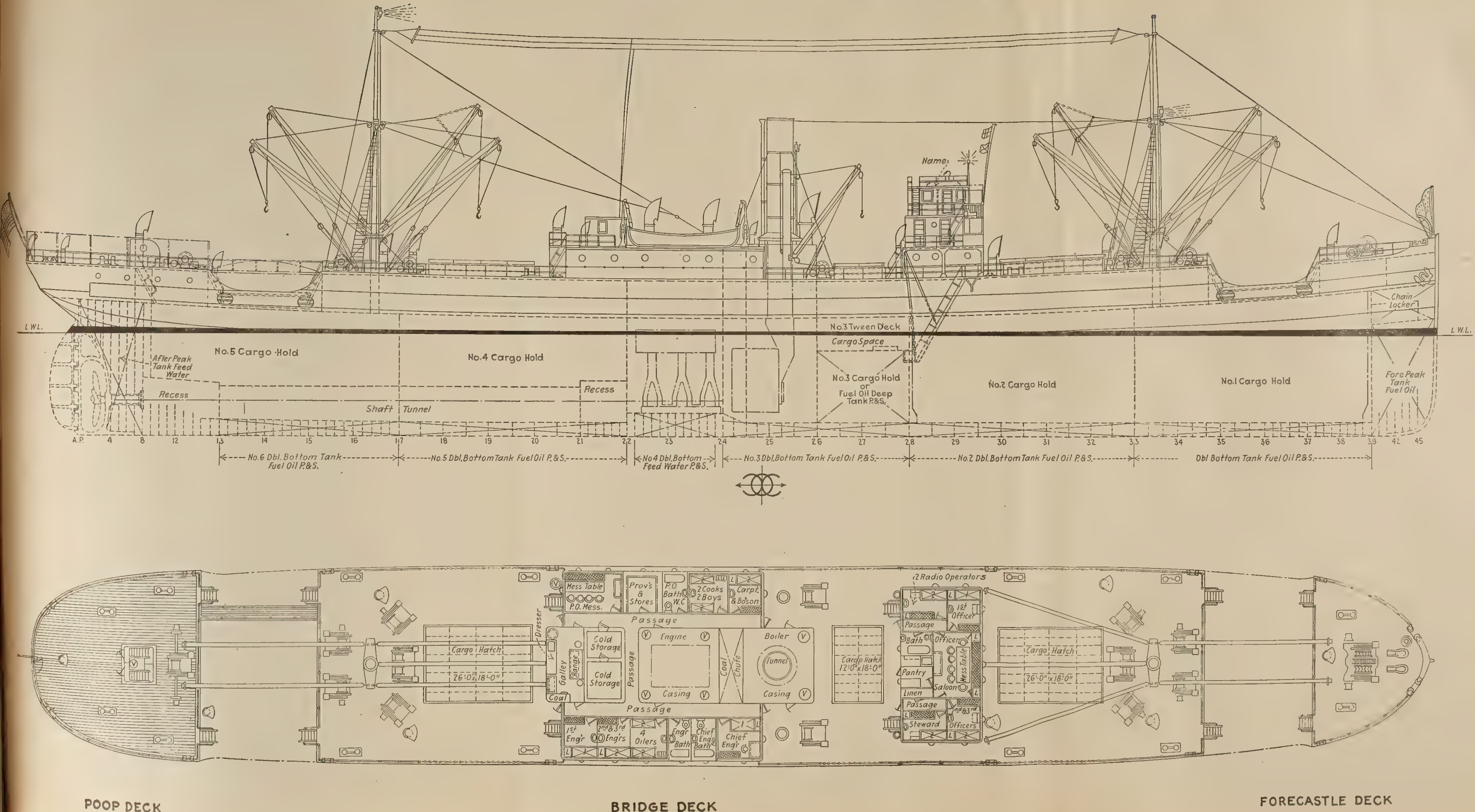
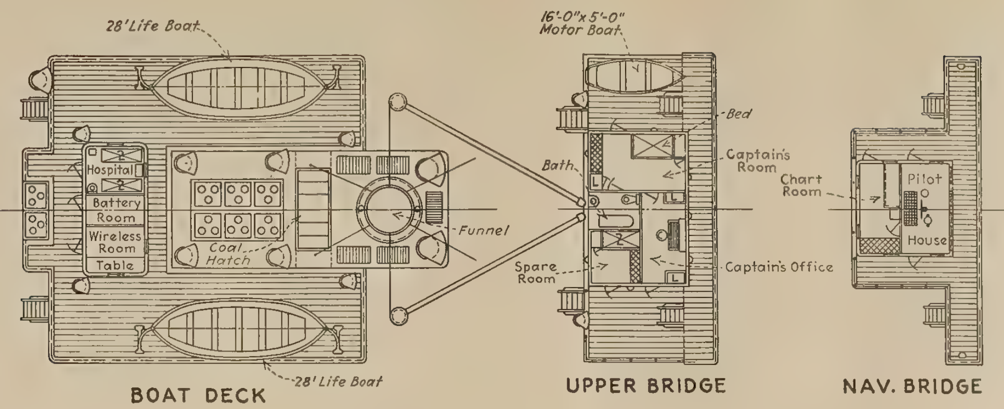


Fig. 2.—Profile and Weather Deck Plans

6,300-TON DEADWEIGHT FREIGHTER

PRINCIPAL DIMENSIONS

Length overall	356 feet 0 inches
Length between perpendiculars	340 feet 0 inches
Beam, molded	49 feet 0 inches
Depth, molded	28 feet 7½ inches
Designed draft	24 feet 9 inches



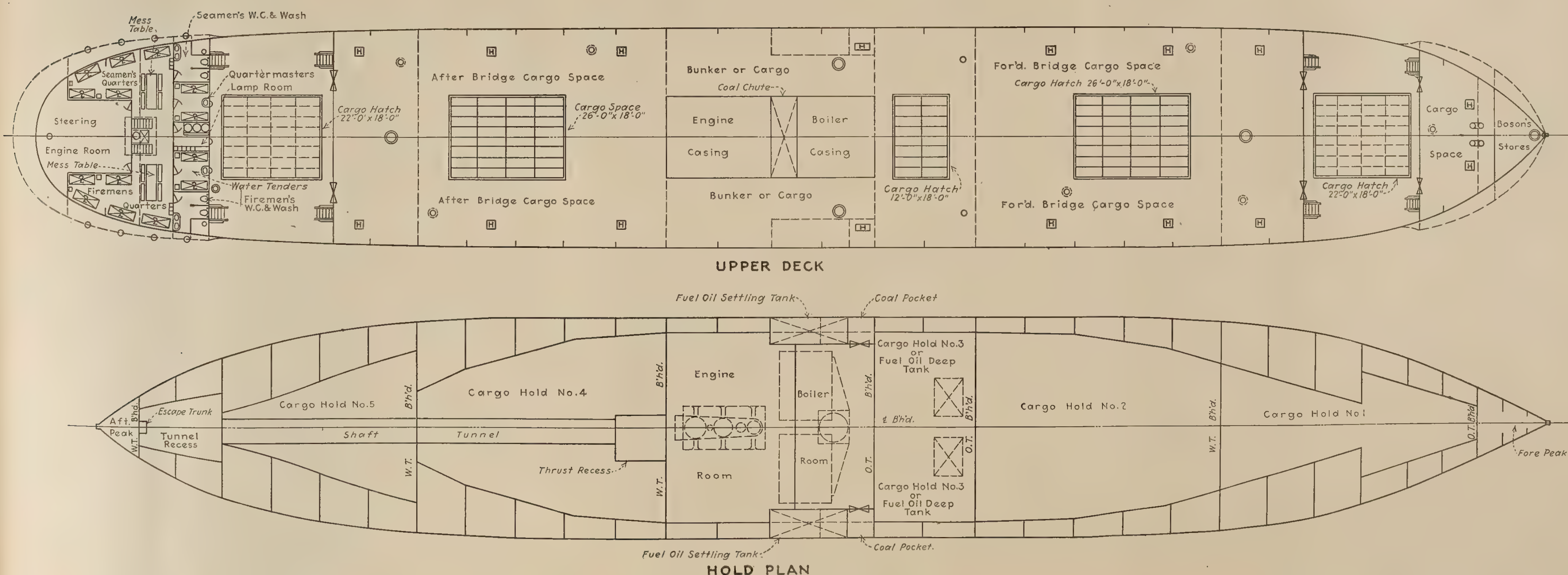


Fig. 3.—Deck Plans

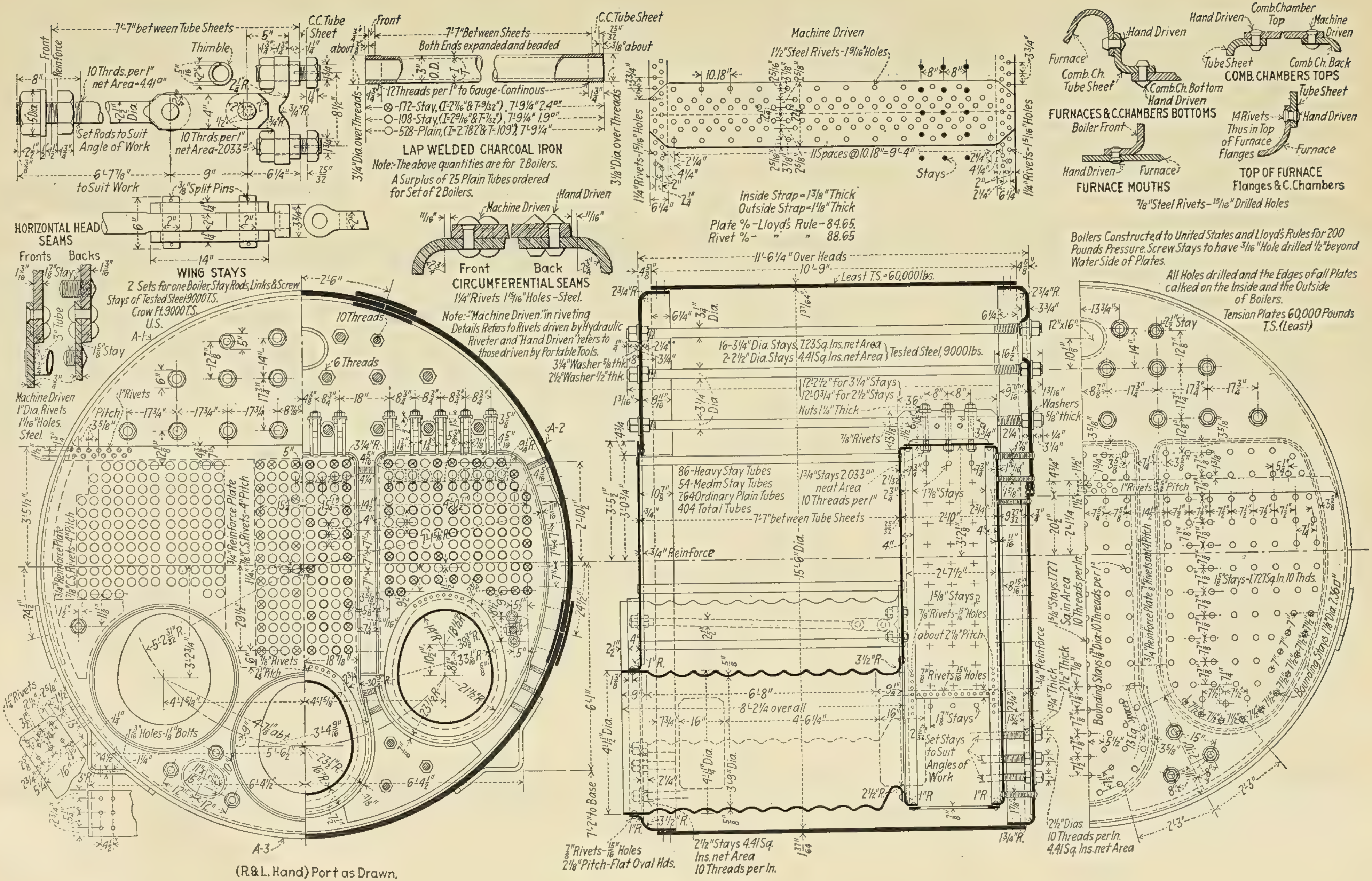


Fig. 4.—Details of Boiler

inches in diameter by 42 inches stroke. At 200 pounds boiler gage pressure the engine will indicate about 2,000 indicated horsepower at 84 revolutions per minute under normal conditions without live steam in the receiver. The air pump, two feed pumps, two bilge pumps and an evaporator feed pump will be attached to the main engine. A main condenser independent of the main engine framing will be provided.

Boilers

The boilers will be of the Scotch type, built for a working pressure of 200 pounds and fitted with the Howden heated forced draft system. There will be two single ended boilers having an inside diameter of 15 feet 6 inches and a mean length of 11 feet 5¾ inches. Each boiler will be fitted with three 45-inch Morison furnaces and with separate combustion chambers. The boilers will be fitted for oil burning, but arrangements will also be made for available coal bunkers and necessary boiler fittings furnished so that the vessel can be quickly converted into a coal burner when so desired.

The shell plating of the boilers is 1 37/64 inches in thickness, of steel having a tensile strength of at least 60,000 pounds per square inch. Inside and outside butt straps are used on the longitudinal seams, the inner strap of 1⅜-inch plate and the outside strap 1⅛ inches thick. To obtain the tube heating surface of 2,852 square feet and the proper staying of the tube sheets, each boiler is fitted with 404 tubes, of which 86 are heavy stay tubes, 54 medium stay tubes, and 264 ordinary tubes 3 inches outside diameter and 7 feet 7 inches long between tube sheets. These tubes are of lap welded charcoal iron. Sixteen 3¼-inch diameter and two 2½-inch diameter long through stays tested to 9,000 pounds are provided for staying the front and back heads.

Requirements for Machinery Installation

Both the boilers and propelling machinery will meet all the requirements of the United States Steamboat Inspection Service, Lloyd's Register of Shipping and the American Bureau of Shipping.

Design data and a comparison of the relative maximum

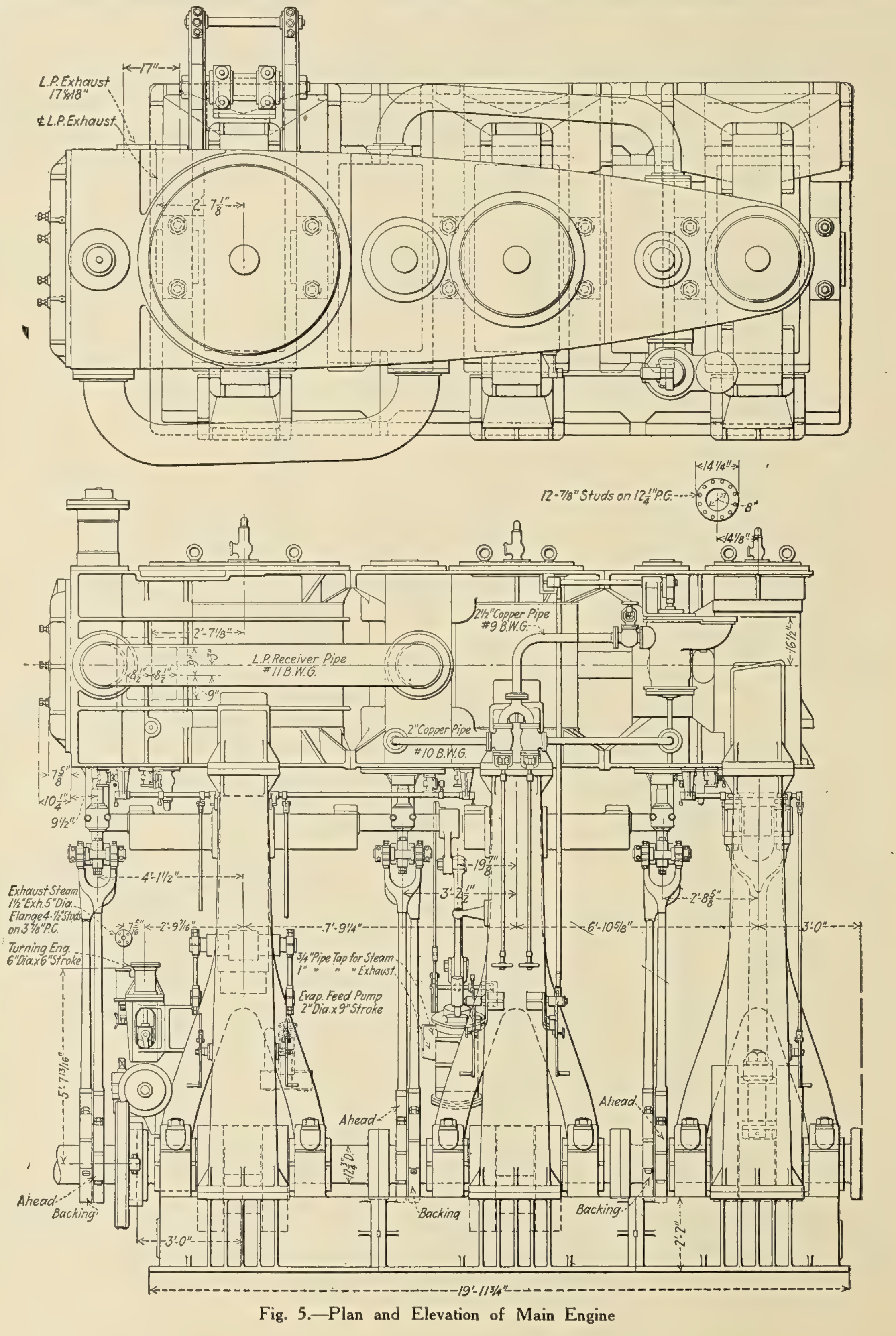


Fig. 5.—Plan and Elevation of Main Engine

value of parts for the boilers are contained in Tables 1 and 2, which follow:

TABLE 1

Data	One Boiler	Two Boilers
Working pressure per square inch, pounds above atmosphere	200	200
Hydrostatic pressure per square inch, pounds above atmosphere	300	300
Heating surface, tubes, square feet	2,406	4,812
Heating surface, furnaces, square feet	140	280
Heating surface, combustion chambers, square feet	306	612
Heating surface, total, square feet	2,852	5,704
Grate surface, 6 feet oil burning, square feet	67.5	135
Ratio heating surface to grate surface	42¼	42¼
Calorimeter, area through tubes, square feet	15.9	31.8
Ratio grate surface to calorimeter	4.24	4.24
Estimated evaporation of water per pound of oil, pounds	13½	13½
Estimated evaporation per square foot of grate, pounds	202½	202½
Estimated evaporation per hour, pounds	13,669	27,338
Estimated oil consumption per square foot of grate, pounds	15	15
Estimated oil consumption per hour	1,012½	2,025
Safety valve, area per United States rules, square inches	13.18	13.18
Safety valve, actually supplied, 3½-inch twin, square inches	19.24	19.24
Steam space, 8 inches above combustion chamber top, cubic feet	410	820
Estimated weight of water, 8 inches above combustion chamber top, pounds	61,800	123,600
Estimated weight bare boiler, tons (2,240 pounds)	50.7	101.4

TABLE 2.—RELATIVE MAXIMUM VALUES OF PARTS

Part	U. S. Rules, Pounds	Lloyd's Rules, Pounds
Shell	203	223
Longitudinal shell joint	...	223
Inside strap, percent shell plate	...	87
Top heads	200	200
Front bottom heads (above middle furnace)	270	225
Front bottom heads (between tube nests)	261	215
Rear bottom heads	270	225
*Rear bottom heads (¾-inch reinforced)	265	238
Combustion chamber girders	210	235
Combustion chamber top plates	232	232
Combustion side plates	257	214
Combustion chamber bottom plates	204	233
Combustion chamber tube sheet	205	217
Combustion chamber back sheet	241	201
Furnaces	207	204
Inner stay tubes	281	351
Outer stay tubes	203	254
Upper main stays, 3¼ inches	206	238
Upper main stays, 2½ inches	236	272
Wing stays, 2½ inches	254	293
Bottom stays, 2½ inches	226	261
Screw stays, 1⅞ inches bounding	244	244
Screw stays, 1¾ inches, girders	261	261
Screw stays, 1¾ inches, wings	217	217
Screw stays, 1⅝ inches, combustion chamber sides	277	277
Screw stays, 1⅝ inches, combustion chamber back	259	259

* 265 pounds for bottom reinforce; 238 pounds for reinforce between stays.

A glance at the arrangement plans accompanying this article will bring out many features of particular interest. Among the most important may be noted the following principal advantages:

The vessel is well adapted to the carriage of bulk cargoes such as coal, grain, etc., as well as the ordinary type of general cargo. The holds are each of almost equal capacity, insuring equal time for loading or unloading each compartment. This results in a more equal distribution of loads upon the ship's winches and gear and insures that the vessel will not be held at the wharf unloading one large hold after the other smaller holds have been completely discharged.

The upper deck is supported by continuous girders at

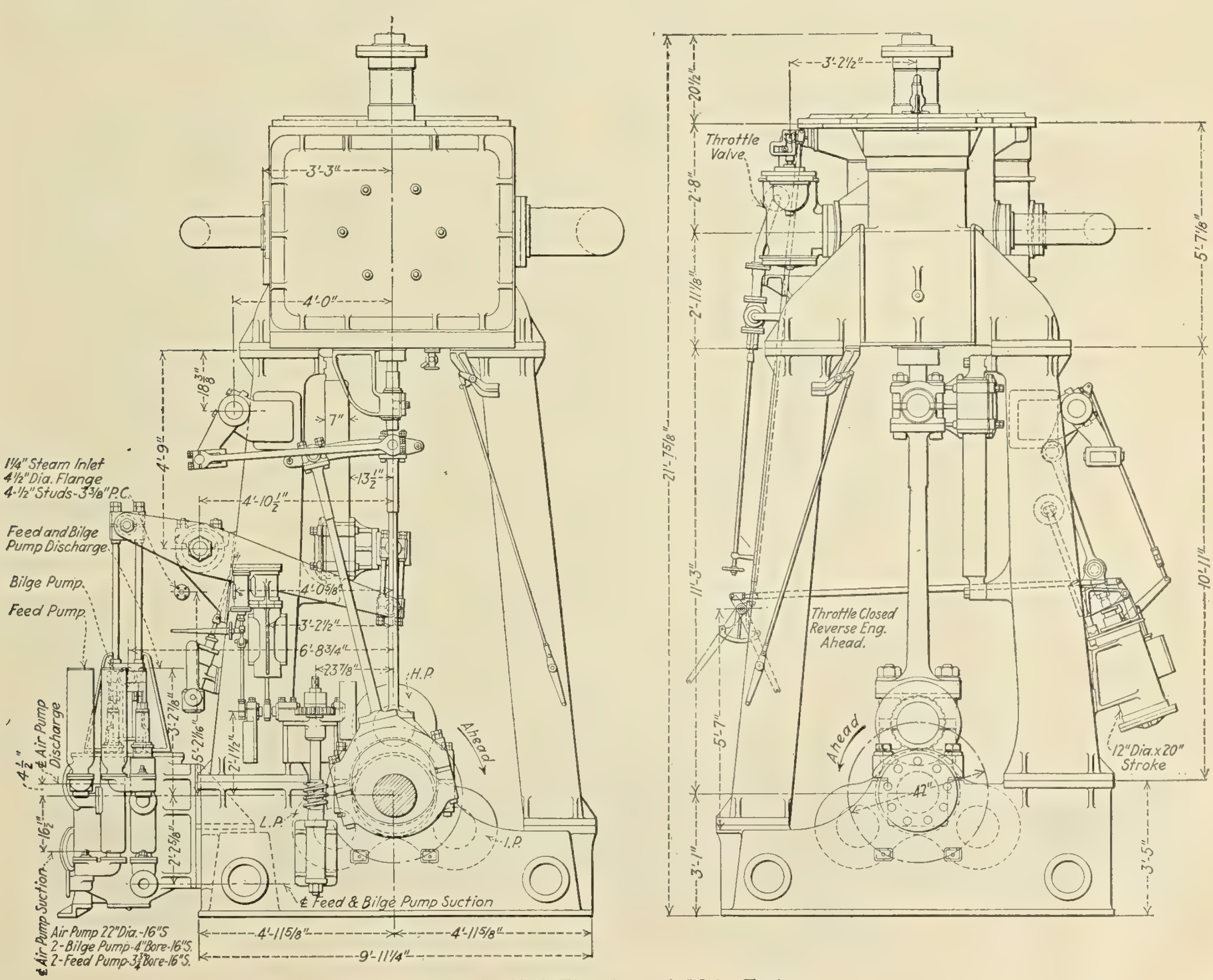


Fig. 6.—End Elevations of Main Engine

hatch sides with one pillar at the center of each hatch side on each girder. Thus each hold has only two pillars and is remarkably free for stowage and handling of cargo.

The hatches are of a capacity sufficient to insure carriage of grain without necessity for bagging. Wood portable shifting boards can be fitted as a centerline bulkhead when grain is carried.

A height of 9 feet has been provided in the long bridge space to permit the stowage of cotton bales three high. The ordinary deck height allows tiering cotton only two bales high with a corresponding large waste of space for the carrying of cargo.

The arrangement of five booms and winches at each mast has been adopted to facilitate loading or unloading the vessel from both sides simultaneously when desired. On this account the middle winch at each mast is of the double independent drum type.

Tonnage openings have been fitted to the bridge space and forecastle for maximum tonnage exemption.

The large fuel oil capacity provides a cruising radius of about 12,000 miles at 10½ knots loaded. Also in case the owners wish to burn coal at any time, part of the bridge space, No. 3 'tween deck space and side coal pockets can all be utilized for bunkers without any alteration to the ship's structure.

Particular attention has been given to the arrangement of quarters throughout the vessel, with especial regard to maximum amount of light, ventilation and comfort.

Particular attention has also been given to the design of the hull form and the propeller, resulting in an unusually easy vessel to drive.

The first vessel to be built in the United States from this design is now under construction, and the results of the trial trip and early service trips will be eagerly awaited.

Electric Propelling Unit of the Eclipse

First General Cargo Merchant Vessel in the United States to Be Equipped with Electric Drive

The original plan of the United States Shipping Board at the peak of its war activities was to build twenty-five ships of the general cargo type to be equipped with electric drive. At the time of the armistice practically all construction work on these ships was suspended together with orders on file with the General Electric Company for the electric propelling units. The cancellation of the ship construction was possible, for work had progressed to only a slight degree at that time, but in the case of the electrical machinery cancellation was not possible without an extravagant waste of useable material, so the United States Shipping Board finally decided to accept ten of the units which might be installed in such of the ships under its present control as would be best adapted for electrical drive. It was hoped in this way to prove the value and economy of this type of propulsion when used on commercial carriers.

Geared Turbines Originally Installed

The *Eclipse* was built by the Union Iron Works, of San Francisco, Cal., during the year 1918 and was originally engined with General Electric Curtis turbines driven through General Electric reduction gears. She is a vessel of 11,868 deadweight tons, 440 feet long, with a beam of 56 feet. The present electric machinery was produced by the General Electric Company, Schenectady, N. Y., and installed by the Vulcan Iron Works, of Jersey City, N. J.

The history of electric propulsion in ships of the Navy is well known to naval architects and marine engineers in general, and the success of the electric installations in the collier *Jupiter* and in the battleships *New Mexico* and *Tennessee* indicated the possibilities of electrically propelling ships in general.

New Development for Merchant Ships

Since the electrification of the *Eclipse,* however, is a complete and new venture in driving large tonnage merchant vessels by electricity, the equipment installed upon the battleships cannot well be cited as a criterion for propulsion on a vessel of this type, since its speed is lower than that of the Navy vessels and the application in general of electrical equipment is quite different.

Bearing in mind that merchantmen are constant speed rather than variable speed vessels, it can readily be seen that the most advantageous use of electricity in propelling this type of vessel would be a powerful but slow speed motor, the initial cost of which should be a minimum.

For this reason a 3,000 horsepower, 2,300 volt, three phase, 50 cycle, 60 pole, 100 revolutions per minute induction motor of the phase wound rotor type directly connected to the propeller shaft is used to furnish the propelling power of the *Eclipse.* This motor receives its cur-

Fig. 1.—S. S. *Eclipse*, the First American Cargo Vessel to Be Equipped With Electric Drive

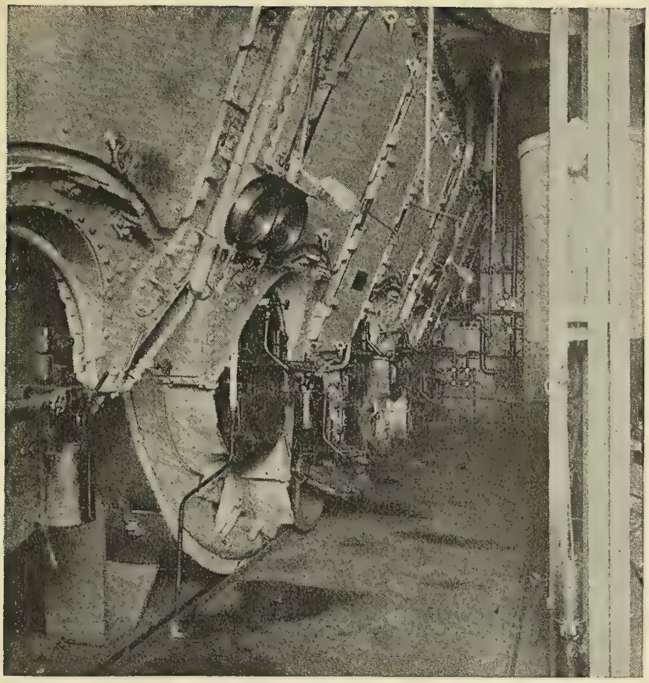


Fig. 2.—General View of Boiler Room, Showing Dahl System for Burning Fuel Oil

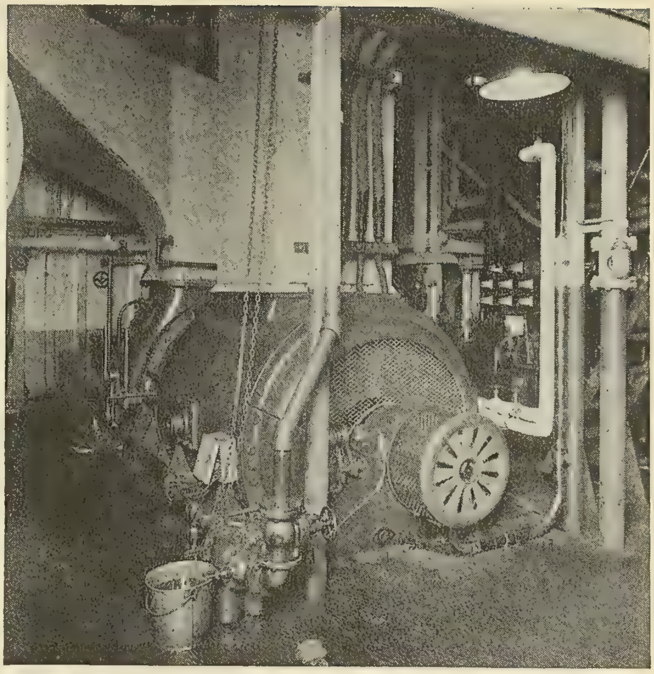


Fig. 3.—3,000-Kilowatt Turbo Generator, Showing Exhaust Pipe to Condenser and Ventilating Hood

rent from a 3,100 horsepower, 2,300 volt, 3 phase, 50 cycle, 2 pole turbo generator whose maximum speed when delivering 2,300 volts at 50 cycles with normal excitation is 3,000 revolutions per minute. Both the generator and motor have been designed especially for sea duty and are provided with non-corrodible fittings, extra high voltage insulation and all windings impregnated against heat resistance and salt water atmospheric conditions. There are also two steam engine driven, 125 volt, direct current exciters and a control equipment for maneuvering the ship.

In detail the turbine is of the horizontal Curtis type operating normally, as noted above, at 3,000 revolutions per minute and is of the type developed specially for marine purposes. The governing system is so arranged that the turbine is controlled by a hydraulic variable speed governor at speeds from 20 to 110 percent of normal. It is further provided with protective devices in the way of a centrifugal type pre-emergency governor controlling the speed up to 15 percent of normal and a ring type emergency governor which prevents the turbine from running at speeds exceeding 125 percent of normal.

The three phase generator of 2,300 volts is especially designed for marine service in conjunction with the turbine unit. It incorporates several features necessary to

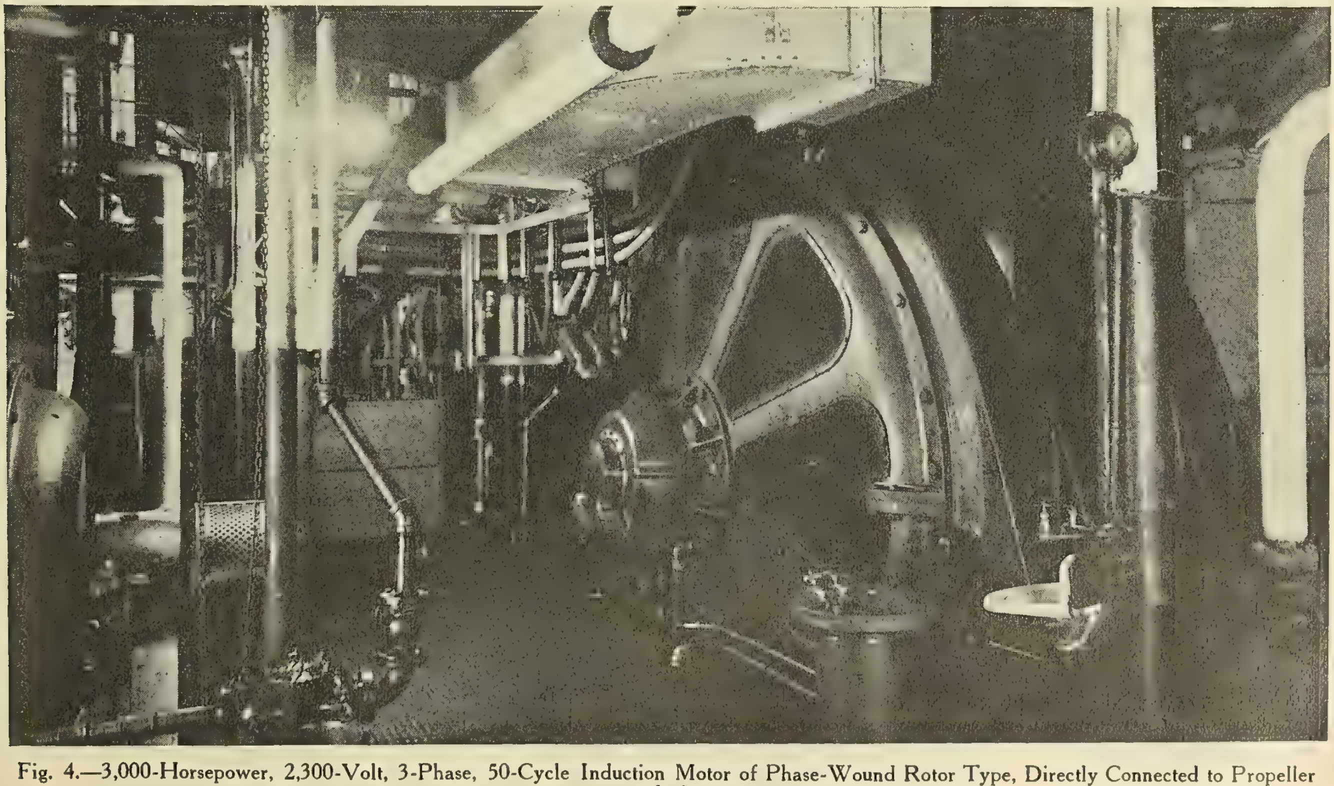


Fig. 4.—3,000-Horsepower, 2,300-Volt, 3-Phase, 50-Cycle Induction Motor of Phase-Wound Rotor Type, Directly Connected to Propeller Shaft

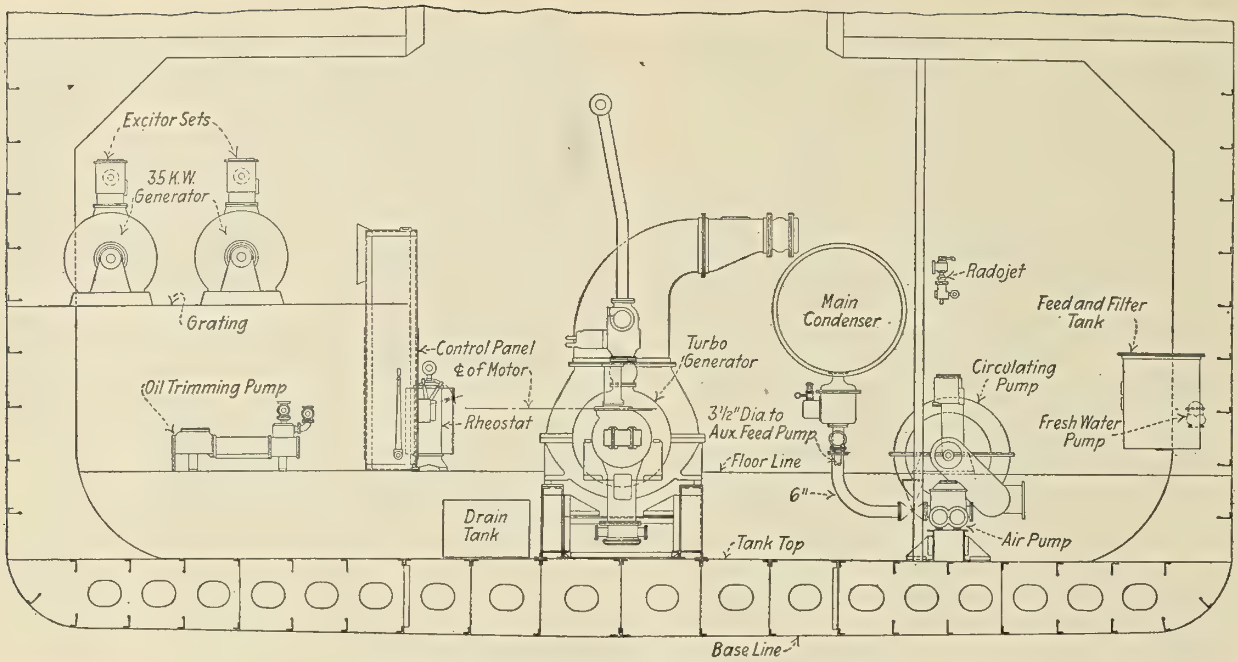


Fig. 5.—Transverse Section Through Engine Room

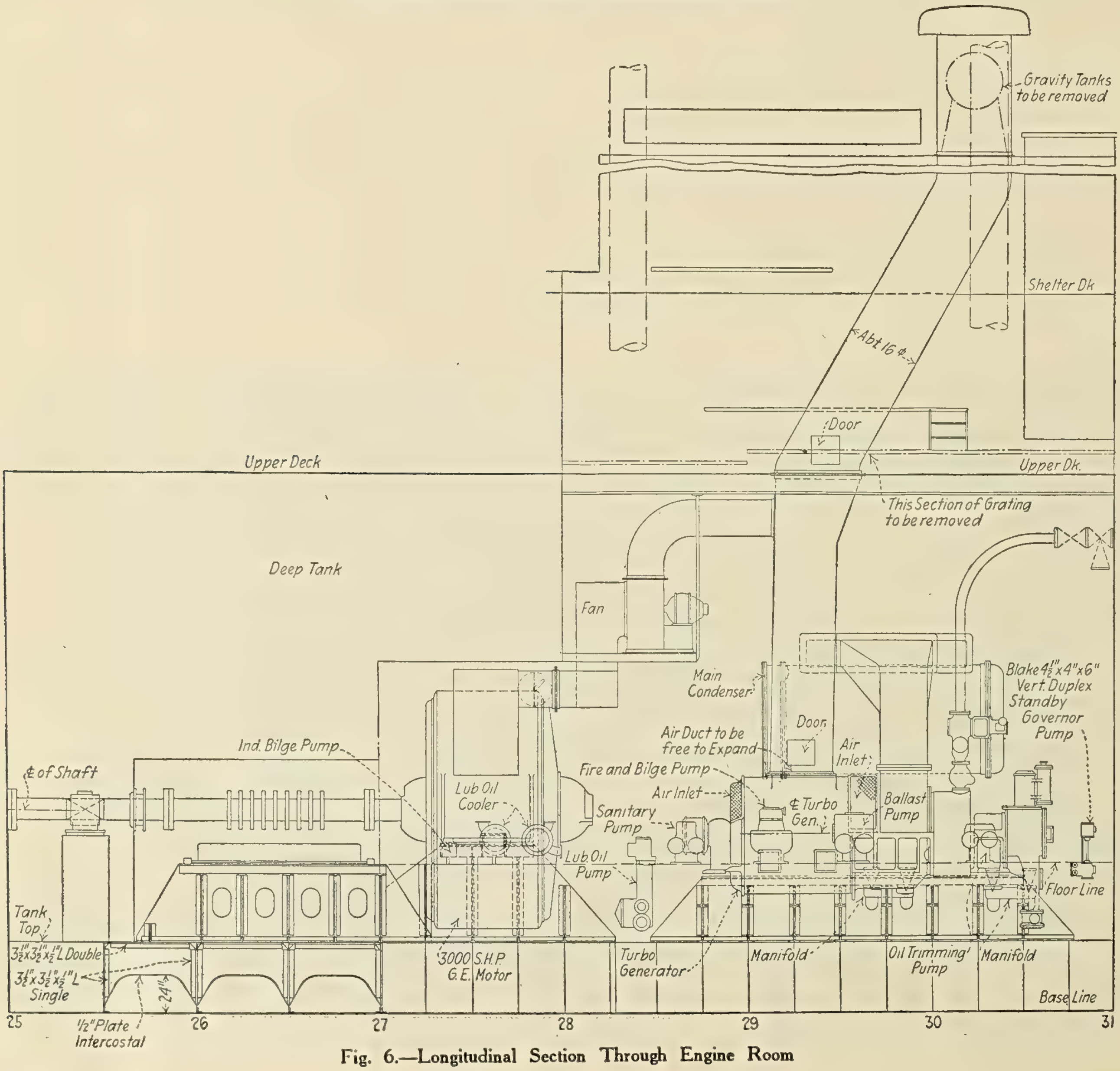


Fig. 6.—Longitudinal Section Through Engine Room

meet the particular requirements of propulsion in a merchant vessel. The stator consists of a cast iron, one-piece frame with openings in the top for ventilation, while the core is built up of annealed segments of thin sheet iron of special material to insure a low core loss. It is held in place by heavy cast iron frame flanges at each end.

The windings are formed coils pressed from enamelled cable, each turn consisting of rectangular strips in multiple. Eddy currents are eliminated by the strips being well insulated from each other. Ventilation is provided by a centrifugal fan mounted at each end of the rotor.

The propelling motor is an induction motor rated at 3,000 horsepower and revolves at a normal speed of 100 revolutions per minute, which gives a total reduction from the turbine to the propeller speed of 30 to 1. The motor is ventilated by a motor-driven blower. Attention is called to the fact that as this machine, in the true sense of the word, may be considered a constant speed motor, in lieu of its windings being fixed for 60 volt and three phase current, it is therefore used in the absence of pole-change winding and double squirrel cage rotor features for variable speeds.

The control equipment consists of a control group, a water cooled resistor and a control panel. The water cooled resistor is inserted in the motor circuit when operating at low speeds and is mounted on top of the control panel. The panel is a structural iron cell faced on one side by a sheet steel plate upon which are mounted all the electrical instruments and the electric and speed lever controllers for the normal operation of the machinery. The two levers are mechanically interlocked to prevent improper starting and running conditions. The electric lever moves a master controller, which in turn energizes the contactors of the control group.

Speed Regulation

Speed regulations for maneuvering the *Eclipse* are governed by a combination of inserted resistance in the phase-wound rotor, together with varying speeds of the turbine whereby both voltage and frequency of the current supplied to its stator windings form a function of the motor's torque and revolutions per minute.

In addition to the speed and electric levers there is a field resistor for regulating the generator field resistance

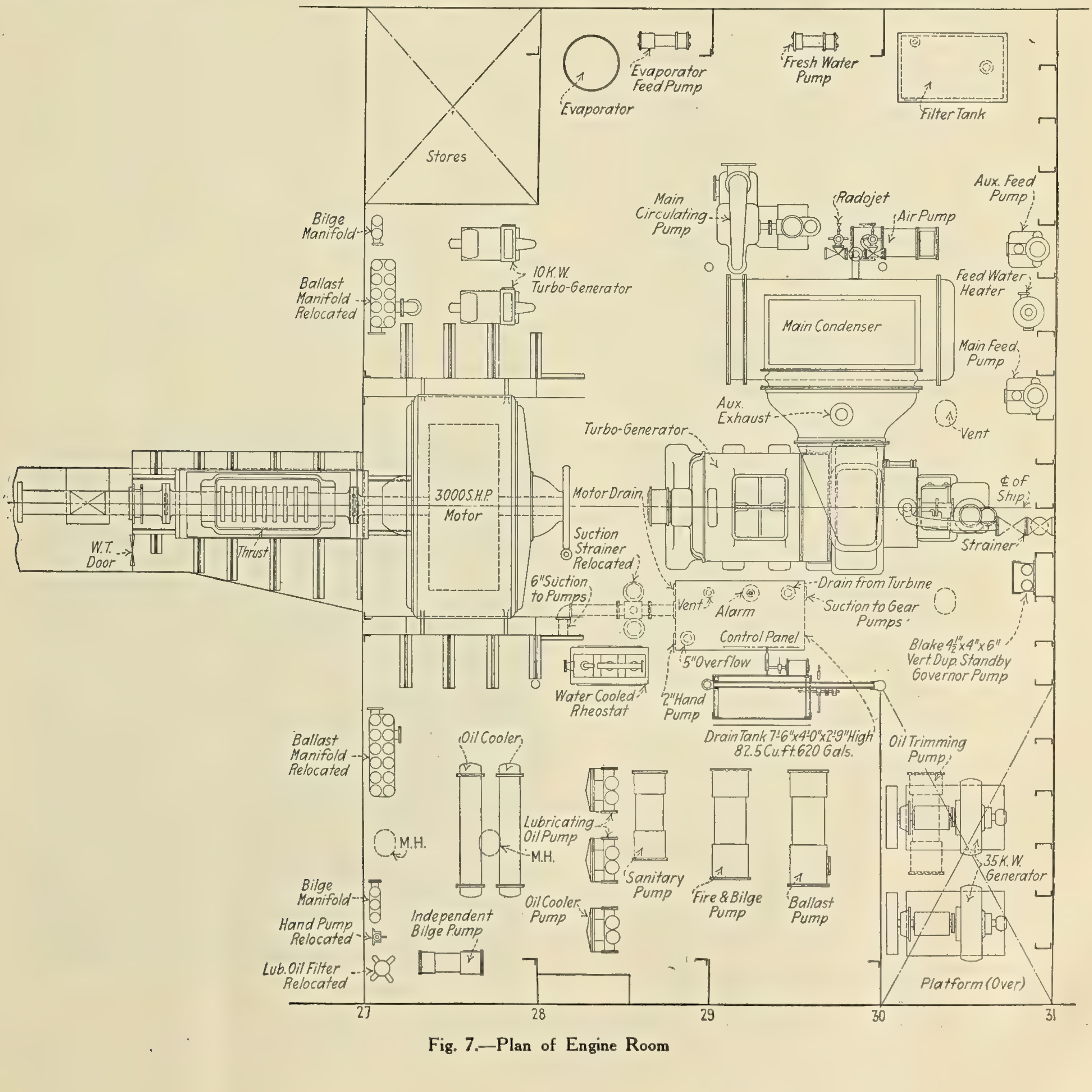


Fig. 7.—Plan of Engine Room

Table I.—DATA ON SEA TRIAL OF S. S. ECLIPSE—October 2, 1920

Hour	Kilowatt Generator	Gen. Field Temp.	Gen. Field Amp.	Volts	Turbine Speed	Excitation	Generator Amperes	Propeller Speed	Excitation Volts	Ampere Exciter	Throttle Pres. Pound per sq. in.	Vacuum Press. Inches Mercury	Boiler Stm. Press. Pounds per sq. in.
8:30	....	...	...	....	950	...	...	...	...	...	205	28¼	215
9:10	1950	...	...	2300	3000	...	700	95	...	...	185	27	193
9:30	1500	100	140	2000	2700	6	650	85	120	190	189	28	184
10:00	1200	110	125	1375	2475	6½	575	79	120	180	189	28½	195
10:30	1600	130	155	2200	2800	6½	650	87	120	190	177	28	179
11:00	1400	125	125	1750	2550	4¾	750	83	120	175	181	28½	186
11:30	1800	125	130	1900	3000	5	700	95	130	190	178	27½	185
12:00	1200	120	115	1500	2400	3½	575	75	120	170	201	28½	210
12:30	1600	140	145	2100	2850	6	650	90	120	195	194	28	200
1:00	2050	140	190	2500	3000	6	700	95	120	240	196	28	205
1:30	2000	145	160	2250	2800	5	700	90	120	195	194	28	205
2:00	2000	150	145	2150	2900	4½	700	92	120	195	195	28½	206
2:30	1950	150	142	2050	3000	2½	700	92	125	192	200	28	210
3:00	1900	140	140	2000	2900	3	700	92	125	195	200	28	210
3:30	1900	145	140	2100	3000	3½	700	95	125	185	200	27¾	208

Hour	Lub. Oil Press.	Cir. Water Press.	Deck Stm. Press.	Throttle Ahead	Superheaters Boiler 1	Superheaters Boiler 2	Superheaters Boiler 3	Superheaters Throttle 4	Oil Gages (Bhd) Thrust Bear. 1	Oil Gages (Bhd) Bear. Oil 2	Oil Gages (Bhd) Hyd. Gear. 3	Oil Gages (Bhd) Gov. 4
8:30	47	9	125	0	...	430	480	420	10½	10½	72	77½
9:10	44	9	125	176	...	540	540	540	10	10¼	87	63
9:30	43	9	125	193	...	510	500	500	10¼	10¼	79	63
10:00	47	9	125	110	...	550	550	540	10¼	10¼	86	67
10:30	46	9	125	135	...	515	490	490	10¼	10¾	84	67
11:00	47	9	125	150	...	550	540	515	10¼	10¾	85	67
11:30	47	9	125	171	...	520	505	530	10¼	10¾	82	51
12:00	47	9	125	150	...	540	535	530	10¼	10¾	86	55
12:30	47	9	125	190	...	530	520	530	10¼	10½	85	55
1:00	47	9	125	195	...	560	560	530	10	10½	85	56
1:30	47	9	125	195	...	550	570	540	10	10½	86	55
2:00	47	9	125	195	...	540	585	550	10¼	10¼	88	54
2:30	47	9	125	199	...	550	530	550	10¼	10¼	87	54
3:00	47	9	125	198	...	540	530	550	10¼	10	86	54
3:30	47	9	125	196	...	530	530	540	10¼	10	86	53

Hour	Oil Gages Turb. Gen. Bear. 1	Oil Gages Turb. Gen. Bear. 2	Oil Gages Turb. Gen. Bear. 3	Oil Gages Turb. Gen. Bear. Aft 4	Temp. Cir. Water Disch.	Temp. Turb. Exh.	Temp. Feed Water	Press. Feed Water	Temp. Cooling Water at Rheos.	Lub. Oil Press.	Temp. Lub. Oil. After Cooler	Temp. Lub. Oil Before Cooler	Temp. Lub. Oil Cooling Water	Fuel Oil Press.	Fuel Oil Temp.
8:30	12½	9	12½	5½	..	..	...	..	C-G	..	..	..	.	...	...
9:10	12	9	12	5½	101	115	208	7½	20	18	83	87	68	175	220
9:30	12	9	12	5½	91	115	200	4½	20	18	85	92	68	180	225
10:00	12½	9	12	6	86	115	215	7½	21	19	89	93	68	200	270
10:30	12½	9	12	6	98	115	235	10½	20	18	90	95	68	185	248
11:00	12½	9	12	6	81	115	225	15	17	19	89	95	63	200	260
11:30	12½	9	12	6	93	115	235	14	19	19	90	96	64	165	250
12:00	12½	9	12	6	87	115	225	14	19	19	89	95	65	215	225
12:30	12½	9	12	6	90	115	220	10	19	19	89	96	65	200	210
1:00	12½	9	12	5½	93	115	210	9	19	19	89	96	65	195	220
1:30	12½	9	12	6	90	115	203	9	18	19	88	96	64	198	225
2:00	12½	9	12	6	89	115	205	9	17	19	87	96	62	200	235
2:30	12½	9	12	5½	95	115	217	10	20	19	89	95	68	180	235
3:00	12½	9	12	5½	95	115	220	14½	21	19	89	96	68	183	230
3:30	12½	9	12	6	98	115	230	8½	21	19	89	96	69	185	222

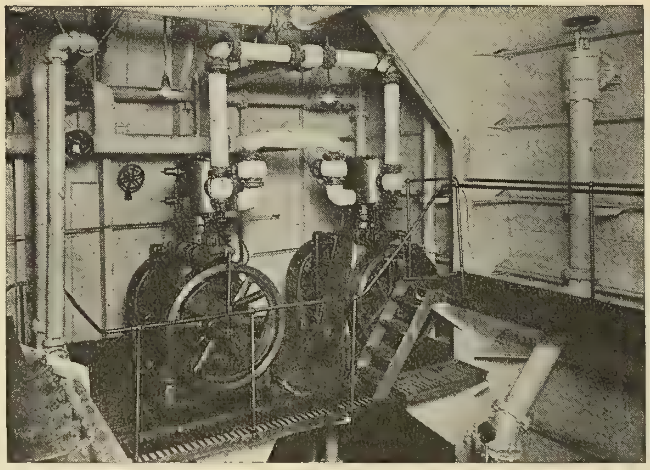


Fig. 8.—Two 35-Kilowatt, 125-Volt Direct Current Exciters

and an auxiliary handle for operating a fused disconnecting switch in the control circuit, leading from the 125 volt power supply to the master controller. There are also levers connecting either exciter into circuits, two exciter resistors, one for each exciter, and levers for connecting the blower and generator field to the exciter bus.

If for any reason it becomes necessary or desirable to operate the control group manually, this may be accomplished by means of three levers mounted at the left side of the control panel. These are, from left to right, the resistor lever, the field lever and the reverse lever, which actuate the contactors directly by means of cams.

An outline of the sequence of operations required for starting and reversing the *Eclipse* or maneuvering is in general as follows:

First, assuming that all preliminary operations had been performed, the turbine is brought up to 25 percent of its full speed by means of the governor control, giving a frequency and voltage of approximately 25 percent of the alternator's normal characteristics.

Second, by means of the electric automatic control

Fig. 9.—General View of Control Board, Showing High-Tension Contactors, Meters, Control Levers and Water Rheostat Which is Connected Into the Secondary Circuit of the Phase-Wound Rotor During Starting and Reversing Operations

lever which is both mechanically and electrically interlocked, as noted above, the main magnetic contactors are closed on the motor circuit with all resistance inserted in the secondary windings.

Third, the automatic electric lever is then advanced, which operation automatically closes the magnetic contactors, giving field excitation to the alternator, causing revolving magnetic fields in the motor's stator winding and consequently the induced current in the secondary winding, which produces a revolving torque.

Fourth, as the motor produces synchronous speed for a frequency of 12½ cycles per second, namely, 25 revolutions per minute on the motor, the secondary resistance is automatically cut out and the phase wound rotor short circuited upon itself by a further movement of the automatic control lever.

Fifth, the motor is then directly and electrically tied in with the alternator, operating as a squirrel cage machine, which means that greater speeds are then obtainable by increasing both the frequency and voltage of the line current, which is done by increasing the excitation to the fields of the generator and opening up the steam throttle of the turbine, whereby its rated speed for a given load may be developed.

Control Operations in Reversing

Exceptionally quick and powerful reversal is effected by throwing the steam lever which controls the turbine governor to one-quarter speed and then bringing the electric control lever to neutral position. The electric lever is then placed in the reversed position, which automatically inserts a secondary resistance and closes the field excitation as it was performed during the starting operation. After the motor approaches synchronous speed for a frequency of 12½ cycles per second in the reversed direction, the electric lever is further advanced on the reverse control, cutting out the secondary resistance and following the same sequence of operations as was performed in the forward movements.

When the ship is under full speed ahead and reversal is desired, due consideration must, however, be given the excitation meter, which is located on the control board, in order that momentarily heavy over-excitation may be supplied to the generator to counterbalance the powerful braking torque that is necessary before and after reversal of the propeller becomes effective.

The excitation instrument that has been supplied with this equipment supersedes all meters that have yet been devised or installed on any electric ship. It indicates to the operating engineer at a glance the amount of field excitation necessary for both heavy and smooth sea sailing, as well as excitation necessary during the periods of reversals.

Acceptance Trials of the Eclipse

The original steam driven auxiliaries in the *Eclipse* have been utilized in the new installation, the electrical equipment having been put into the vessel with the least amount of alteration of the installation as it existed. Before the vessel was taken over by the Shipping Board to be used in the service of the American Line of the International Mercantile Marine, she was given a six-hour sea trial, the results of which will be found in the accompanying tables. The trials were satisfactory so far as the performance of the vessel was concerned, although no conclusive estimates could be made of her possibilities in actual service, since the trial was run with the ship in ballast, the propeller being about 18 inches out of water.

TABLE II.—RESULTS

Kilowatt hour meter reading at start of trial	0017.8
Kilowatt hour meter reading at finish of trial	0029
Constant kilowatt hour meter	1000
Total kilowatt hours used on trial trip	11,200
Total oil used on trial trip, less 5 percent slip for meter inaccuracy, gallons	3,220

Temperature of motor stator at finish of trial—forward end, 52 degrees C.; astern side, 59 degrees C.
Engine room temperature varied from 30 to 33 degrees C.
Temperature of rotor at finish of trial—46 degrees C. on astern side; 48 degrees on forward side.

Do Not Kill the Goose That Lays the Golden Egg

BY "OLD SCOTCH"

I am addressing these plain and frank remarks primarily to American marine engineers, and secondarily to all Americans interested in the success of our merchant marine. The writer is a marine engineer himself and has not a dollar invested in shipping; consequently, he is making this appeal from a friendly interest in marine engineers and an intensely patriotic desire to see our merchant marine succeed.

FOR the past three or four years golden eggs have been dropping in your baskets, my marine engineer brothers, in a number which you hitherto have never dreamed to be possible, as your wages have grown to such an extent that you are well fortified in combating all your legitimate expenses. Your pay is much higher than the wages paid for like services on the ships of any other nationality. That is as it should be, as you are Americans and entitled to the best. But there are obligations on your part which must be fulfilled faithfully and energetically, if these "golden egg" days are to continue.

First you must distinctly understand that the world's shipping is an "open shop" of the very openest type. All nations are free to compete for the business, and American ships are not favored one bit in the keen competition. The American shipowner does not receive a penny more freight money for the goods he transports than does any other shipowner in the wide world. We all know that to pay out money we must first receive it. Now with our income limited in shipping, we must carefully guard our outgo, or to reverse it, we will *"go out"* sure enough, and good-bye golden eggs in the shape of high wages.

The engineers on any ship are the principal class of employes who can make ship operating a success or a failure. On your efficiency the whole enterprise must depend to a very great extent. Deck officers may dress in cleaner clothes, and if they are successful in keeping the ship out of collisions or from striking the beach, it makes but little difference how efficient they are otherwise so far as the financial success of the ship is concerned.

Fuel and repairs are two of the important items of expense in operating the ship, and for these you engineers are directly responsible. If you are not skilled in your business and are careless, you can easily waste not only all the profits of a voyage but have the ships run at a loss besides. You can give one guess as to how long an owner will continue to run his ship at a loss, and when ships don't run, where is your job going to be? I regret to tell you that some of you are leading up to just such an ending, and unless you reform at once many of you will be out of a job before many weeks have passed. Some may say that this is a lot of "bunk," but let me quote you some recent figures from an absolutely reliable source. They represent monthly averages of three vessels operated under the British flag, and three operated under the American flag, all under the same ownership and engaged on the same routes. They are all oil carriers and average 11,500 tons deadweight each.

Relative Costs of Operating American and British Ships

For provisions the British monthly cost for each ship was $1,495, as compared with an American cost of $2,300, showing that you are fed better on the Yankee ships.

For deck stores the British paid $1,035 per month on each ship, and the American only $805 per month, showing that our deck officers must have been more economical than the British in this small item of costs.

For engine room stores the British monthly charge was $460 each, while American engineers used $805 worth.

The wages for officers and men cost each of the British ships $3,680 per month, while the American cost was $4,370, showing plainly who gets the better pay.

Now comes the item of repairs, and we find that while each British ship paid only $1,265 per month, the cost per month on each American ship was $7,245. Just think of that—fifty percent more than the entire cost of wages of officers and crew every month! True, this was the cost of the repairs to the entire ship, but the bulk of them was in connection with the steam machinery. Neglecting depreciation, interest charge, fuel, insurance and port charges, which should be about the same on ships of any nationality engaged in the same trade routes, the increase in cost of operation for each American ship over that of the British ship was $7,590 every month.

Where is that to come from? They each received the same amount in freight money. Do you think that because of the past great demand for shipping this condition of affairs can go on indefinitely? No, my friends, American shipowners are not philanthropists and they will not continue to run their ships at a great loss just to give you engineers and deck officers good jobs at high rates of pay. Disabuse your minds of that idea very quickly.

Just keep in mind that the ships I have quoted above are privately owned where such conditions existed. The Lord only knows what the cost of repairs and stores have been on the Shipping Board ships during the same period.

Overtime Charges Ruinous

Another iniquitous thing that is being put across is this pay for overtime you are demanding and getting at this time. When I first went to sea and when you older men went to sea, an engineer who asked for overtime pay in case he worked over eight hours per day would have been thrown on the beach in about two seconds. Many of you are putting off jobs that you should do during your eight-hour shift, so that you can soak the owners for overtime, when you do something which you ought to have done on your watch. Some of you are getting $50 to $100 a month for this overtime, in addition to the already big wages you receive. Now don't think that you can get away with this kind of action very much longer. Already vessels are being withdrawn from trade owing to the rapidly diminishing freight rates. Many more will follow, if you continue to neglect your jobs and allow these enormous charges for repairs and overtime to roll up as you are doing now.

I am told that many of you want to do these small repairs but that your men are no good and that you have some Bolshevists among them who keep the men disgruntled. That is, I'm afraid, too true, but the good, old-time engineers of not many years ago had a way of handling such scalawags, which you might try a hand at now if you are in earnest. Take them one at a time in a coal bunker and "argue" with them in the good old-fashioned way. You know the way I mean. That ought to cure Bolshevistic tendencies.

Many of you men now holding licenses are new at the game and consequently have not been through the mill of hard times. Just listen then to the older men in your organization. They know that what I have told you is absolutely true. All this war stuff and scarcity of ships is over right now, and if you want to continue to hold your good jobs you had better begin to mend your ways and cut out all this foolishness. Striking isn't going to do any good, as it might be a good thing to tie up a good many of the ships that are beginning to be operated at a loss. We must, from national pride and for national interests, have a merchant marine, but if you men are not willing to do your part towards it, then the whole thing will go to smash and you will soon lose the best jobs you ever had in your lives or ever dreamed of having.

What would happen on English, Norwegian or Japanese ships if such repair bills were run up as have been run up on American ships? They don't get as good wages as you do, and they don't have the nerve to demand overtime, but they are running their ships more efficiently than we are.

Aren't you as good engineers as these fellows? Have you no pride in your business or in your country? I have been boosting American marine engineers all my life, as I believe in them. I know that you are as capable as any who sail the seas, and I want to see our merchant ships compete with the world. You can keep them going if you want to do it. I appeal to your pride as Americans, and, above all, I appeal to your self-interests, if you want to hold so many good jobs as you are now holding. I am glad to say that these criticisms apply to a comparatively small number, but few as they are they have caused a great deal of unfavorable comment which you will readily understand reflects on the whole engineering brotherhood. You should be the first to rid yourselves of these undesirables, and, knowing you as I do, I have every confidence in you to do that very thing.

It's a good fat goose, I'll admit, but her golden eggs have an end to them, if you don't watch out.

The Bureau of Navigation, Department of Commerce, Washington, D. C., reports 128 steam motor and sailing vessels of 259,611 gross tons built in the United States, and officially numbered during the month of September. This total includes 28 vessels of 159,114 gross tons built for the United States Shipping Board. Tanker tonnage for the month amounted to 63,571 gross tons, of which four vessels were for the Shipping Board and five for private companies. In addition to this construction, seven vessels of 2,351 gross tons were built for foreign account.

What Will Congress Do?

BY WALDON FAWCETT

What will Congress do? This is a question that is always in order with American business men at the opening of a session of the national legislature. For shipping and shipbuilding interests it has, however, particular poignancy at this juncture. So numerous are the pending problems that have contact directly or indirectly with the merchant marine, and such, in many instances, is the pressure for solution, that it is inconceivable that the law-making body can function without taking action of some significance to the industry.

THE rather unusual situation that exists justifies in shipping and shipbuilding circles an expectation of developments at a "short" session of Congress. It is axiomatic at Washington that Congress is loath to initiate new policies or launch projects that mortgage the future at a session that ends by limitation in three months. Perhaps senators and representatives hesitate to take up issues when they are forewarned that debate will be cut short, but whatever the animus it is proverbial at the capital that the so-called short sessions of Congress are given over largely to the passage of appropriation bills and other measures requisite to the continued operation of the government.

In the present instance there is added an extra influence for inaction. The impending session marks the final fling of the Sixty-sixth Congress. It follows hard upon the heels of a national election which, aside from embodied popular expression upon Congressional policy, has served notice upon a certain proportion of the lawmakers that their services will be no longer required. To this extent the final session of a dying Congress is inevitably an anticlimax. And when, as in the present instance, we have the dominant force in Congress at odds, politically, with the executive administration, there is every encouragement to mark time pending the new day.

Congressional Reaction to Merchant Marine Problems

Despite all these deterrents and in disregard of the further fact that it is confidently predicted that the new Congress will be called in extra session early in the spring, there is virtual certainty that the interim between December 1 and March 4 will witness Congressional reaction to certain merchant marine problems. The policies and performances of the United States Shipping Board, the enforcement of the new Merchant Marine Act, the adjustment of the claims of wooden shipbuilders, etc., etc., present angles that seem certain to enlist controversial attention whatever interpretation be placed upon the November verdict at the polls.

Undoubtedly Congress, and especially that proportion of its membership that has won re-election, will return to the legislative treadmill with minds more or less inflamed on merchant marine issues. To an extent unparalleled in the recent history of the country have these been made the subject of campaign debate. Our readers are familiar, for example, with the discussion that has waged over such questions as the legality of action taken by a minority of the prescribed membership of the Shipping Board; the sanction of an alliance between a subsidiary of the Shipping Board and the Hamburg-American interests; and the refusal of the President to carry out the provisions of that section of the Merchant Marine Act dealing with the abrogation of treaties which are counter to the new Federal policy of discriminatory tonnage dues and duties on imports. Without attempting to forecast precisely regarding the manifestation that will appear, it may be anticipated that the sequel of the campaign analysis of merchant marine problems will have impress upon both the Sixty-sixth and Sixty-seventh Congresses.

Any experienced watcher of the play of partisan politics might surmise that a Republican Congress would lose no time in reacting to the refusal of a Democratic President to carry out an important provision of law enacted by the aforesaid Congress. It is uncertain, however, whether Congress will be precipitate in grappling with the foreign entanglements of the Merchant Marine Act. There will be talk in the halls of Congress, just as there has been talk "on the stump," extending to such lengths as suggestion of the impeachment of the President, but when it comes to action in insistence upon the will of Congress there is encountered a considerable sentiment in the expiring legislature in favor of passing the entire responsibility to the new Congress. By the by, it is coming to be realized in official circles generally that pronouncements from the Supreme Court of the United States may be required on questions of constitutionality involving sections of the new law other than the one dealing with foreign treaties.

Enforcement of Merchant Marine Act

Postponement of action with respect to the full enforcement of the Merchant Marine Act has, in the eyes of some interested persons, the merit that it would allow time for a crystallization of whatever resentment and retaliation may have been engendered in foreign quarters. In other words, there is a feeling on the part of some that, if it should prove necessary to put new teeth in the Merchant Marine Act, it might be just as well to hold off until it becomes apparent what form alien antagonism or competition is to take. Already, for instance, there is conjecture in responsible quarters whether it may not be necessary, in the interest of a merchant marine that shall be bona-fide American, to stiffen the requirements as to American control in corporations that may acquire contracts, shipping or shipbuilding property from the government.

In passing it may be remarked that, if any participant in the industry is prone to be bothered by rumor, he has had ample reason for disquietude in the gossip that has had circulation in and out of print ever since foreign interests began to take umbrage at the effort to establish a merchant marine worthy of the United States. First came the stories of a possible diversion of ships, which seemingly worried certain port authorities on the Pacific Coast, and gradually the propaganda progressed until it brought forth the alarm that foreign interests intended to purchase and dismantle the Hog Island shipbuilding plant as a means of curtailing American resources for the upbuilding of a merchant marine. Action of the Shipping Board in declining to comment on some of the rumors set afloat has, in some instances, but added to the unrest that has been occasioned.

Investigation of Shipping Board Operations

While it is doubtful to what extent, if any, the Congress that is about to close up its business will indulge in what might be termed new legislation relative to the merchant marine, it is reasonably certain that we shall have a continuation of the investigation of Shipping Board operations. So exhaustive were the hearings, touching incidentally upon this subject, before the commerce committee of the Senate that there appears little disposition to reopen the inquisition in the upper house of Congress. The situation is different, however, in the House of Representatives. Here there remains, primed for further action, a select committee on United States Shipping Board operations composed of Congressman Joseph Walsh, of Massachusetts (chairman); Patrick H. Kelley, of Michigan; Lindley H. Hadley, of Washington; Israel M. Foster, of Ohio; Henry J. Steele, of Pennsylvania, and Tom Connally, of Texas.

"Claims" of Shipbuilders Awaiting Settlement

One circumstance that renders it certain that Shipping Board practices and policies will continue to claim considerable attention, not only from the Sixty-sixth Congress in its final days but likewise from the Sixty-seventh Congress, is the number and aggregate magnitude of the "claims" of shipbuilders awaiting settlement. The claims of the wooden shipbuilders for reimbursement for investment, etc., have been mentioned as one of the most formidable war-incurred responsibilities of the government, but there are ramifications of this claim's question that are far-reaching. For example, there are shipyards that have changed ownership or gone into the hands of receivers or otherwise come in for change of status that begets complications when it comes to the adjustment of claims.

The matter of the "extras" allowed or expected to be allowed on the ship construction contracts entered into by the United States Shipping Board Emergency Fleet Corporation is in itself a potential source of disagreement and misunderstanding, the heritage of which is likely to long survive. That this is so is due in no small measure to the fact that a number of shipbuilders, while engaged in government work, kept no detailed record of "extras" and of the time, labor and material going into these extras. The shipbuilders pursued this course under the impression that in the final adjustment they would be allowed lump sums for extras. Accordingly, when in the rush and hurry of wartime shipbuilding inspectors gave oral instructions for this or that change, these instructions were followed in confidence that all the slack would eventually be taken up in a cumulative settlement for extras. This explains the shock and disappointment suffered by some shipbuilders when question was raised as to the propriety of payment of lump sums of as much as $50,000 per vessel for lumped "extras."

Miscellaneous Measures

Aside from the pending legislation to adjust the claims of shipbuilders there are a number of miscellaneous mercantile marine matters before the Sixty-sixth Congress that stand a reasonable chance of being brought to vote in consequence of a desire on the part of their authors or sponsors to obtain a verdict from the existing legislature. This is the case with bills upon which hearings in committee have been conducted. If the current Congress is allowed to adjourn *sine die* without action upon a proposition of this kind, it means that valuable time must be lost, since the measure when reintroduced in the new Congress is likely to be recommitted to committee and all the ground that has been covered by the hearings must be again traversed in new hearings. The urge for conclusive action is even more acute in the case of bills that have been approved in one house of Congress but lack the endorsement of the other house because not yet reached on its calendar.

As has been said, there are a number of bills whose fate thus hangs upon the willingness of this Congress to act in the three months of its tenure that remain. In this category are the measures to provide for the classification of United States vessels; to permit a limited number of passengers on cargo ships; to establish load lines for vessels, etc. A line of contemplated legislation upon which expectations remain unfulfilled is that which seeks to encourage American citizens to enter the merchant marine by holding out concessions such as a reduction in the length of sea service required on training ships. There are also optimists who hope that this Congress, ere it departs, will legislate further in encouragement of the provision of all-American insurance facilities for the merchant marine.

Almost as interesting to many shipping and shipbuilding interests as the prospect for new legislation affecting the technical side of the industry is the outlook for legislation designed to relax the present exactions of Federal taxation. While the Merchant Marine Act affords a loophole for firms that are in a position to contract for the construction forthwith of new tonnage, there are countless firms in the maritime field that, shut off from even this form of consolation, await anxiously a revision of the income and excess profits taxes.

Federal Taxation

While popular sentiment has crystallized markedly in favor of an overhauling of the Federal taxation system, it cannot be said in all candor that there is any reasonable assurance that Congress will attempt action at the short session. Rather does there appear to be a disposition in Congressional circles to postpone the revision of the system of internal revenue until it can be considered in conjunction with the problems of a general revision of the tariff which it is confidently predicted in many quarters will be attempted by the new Congress. With the new vision of American participation in the world's carrying trade, United States maritime interests will be impelled to watch closely the evolution of a new tariff policy. That Great Lakes commerce no less than overseas trade may be affected by the tariff changes that are in prospect in this and other countries is hinted by the fact that a spirited contest is now on in Canada to determine whether the Dominion shall adopt a policy even more pronouncedly protectionist than it has followed in the past, for all its anti-dumping act and its disdain of the United States offer of reciprocity.

With the marked trend in the maritime field from coal burning to oil burning steamers there will be supplied definite incentive for shipping men to watch closely the progress of national legislation that deals with petroleum and kindred natural resources. In this same connection the statement may be ventured that by no means all shipping men have as yet sensed the significance of the Oil and Gas Leasing Act which Congress approved in the early part of 1920. Similarly, not all the shipping men who are dependent upon liquid fuel appreciate that legislation governing international relations, say relations with Mexico, is likely henceforth to have a meaning all its own for builders and operators of oil burners.

Patent Legislation

Half way through Congress, and consequently an object of especial conjecture, is a measure whose significance to the shipbuilding and ship outfitting industries has not been generally appreciated. The measure is one that would empower the Federal Trade Commission to administer the inventions made by experts and employees in the service of the United States Government. It is designed to render available for the fullest commercial use many valuable discoveries and inventions which under present conditions are not exploited.

As readers of Marine Engineering are well aware, specialists in the United States Navy and in engineering and technical divisions of the public service perfect, every now and then, inventions that would prove quite as serviceable in the merchant marine as on the governmental craft for whose purposes these innovations are, we will suppose, primarily designed. In the case of none of these inventions has the government, in time of peace, maintained a monopoly. Quite the contrary. Patents taken out upon inventions worked out on government time and with government facilities have usually been dedicated to the public.

Evidently, however, the very liberality of this intent to share with private industry the fruits of Governmental research has defeated the purpose that it was sought to accomplish. It has been found that, as a rule, private manufacturers have been loath to place on the market the inventions that were, in accordance with Federal policy, open to all comers. The explanation given universally in the case of inventions that would require any considerable plant equipment was that no manufacturer could afford to risk the investment necessary to bring about production on a commercial scale when his enterprise might be penalized by any or all competitors who saw fit to enter the field once the pioneer had created a market.

It is this undue freedom of competition that the measure now before Congress is designed to correct. By its provisions the Federal Trade Commission would be empowered to conduct a clearing house for all governmental inventions that might be found worthy contributions to the world's mechanical and scientific equipment. Each invention having merit will be patented, and instead of a free-for-all policy the Trade Commission will restrict manufacture under the patent to one or more duly approved licensees. The intent is to authorize manufacture in each case by a sufficient number of manufacturers to insure adequate production and a proper degree of competition, but to avoid overproduction by promiscuous manufacture, and yet, more important, to give to each licensee reasonable assurance of a sufficient volume of business to warrant the needed investment for factory, patterns, etc. It is contemplated that modest royalties be charged on all inventions. The revenue thus provided would cover the cost of administration of the license system and also afford to each inventor in the government service a small bonus that would be an incentive to creative effort.

Likewise, half way through Congress is another patent bill of more or less moment to shipbuilding, equipment and supply interests. This measure undertakes to remedy conditions at our overworked and undermanned Patent Office by an increase of the examining force and a horizontal increase in salaries—the latter designed to hold in the service the trained experts so essential to efficient administration of the patent system. Interests in the maritime field that have been inconvenienced latterly by the well-nigh intolerable delays in passing upon new inventions, original designs, etc., would welcome the betterment of conditions that is half promised.

Comparison of Cargo Transportation by Land and Water Routes*

BY WILLIAM T. DONNELLY†

THE building of many canals all over the world in years gone by bears testimony to the fact that transportation of cargoes on the water costs much less than by overland routes. The present development of inland waterways in this country and especially the barge canal in New York State is based on the same sound principle. What then is the explanation of the public attitude towards these enterprises other than the effect of the opposition of the railroads to their exploitation?

A careful survey of the whole subject indicates very clearly that the canals and inland waterways, as used, lack dispatch. They are too slow. The public mind associates the canal barge with a mule's pace—his walking gait—and shipments by this method only appeal to the public as suitable for cargoes of non-perishable, almost non-essential, freight of such a nature as to be unaffected by the rapid fluctuations of market conditions. The shipper takes the same attitude and forwards his goods by rail. Fast freight and express are the terms that appeal to him, so that he may deliver his goods to a given destination quickly and turn over his investment.

However, fast freight is no longer fast, and even the express is slow. Moreover, both methods of shipment are

* Paper read before the Atlantic Deeper Waterways Association Convention, Atlantic City, October 7.

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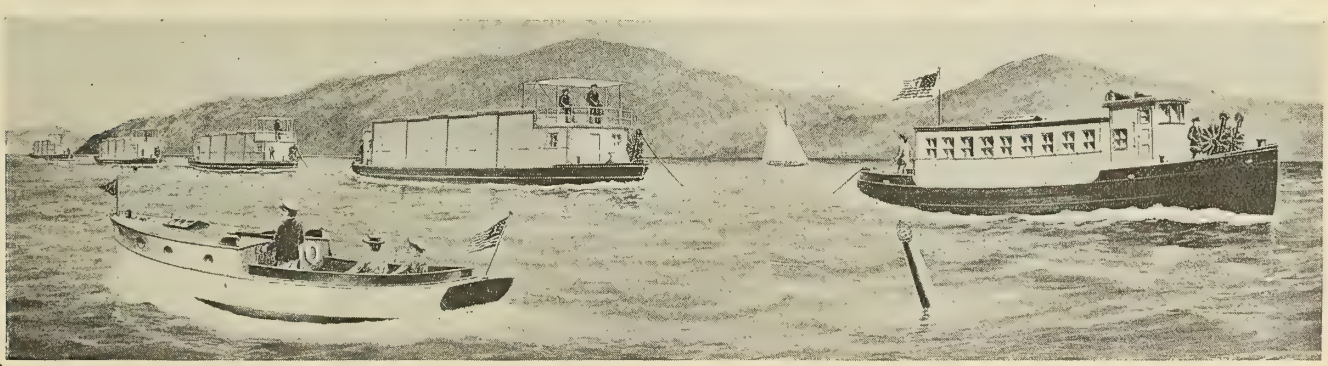


Fig. 1.—Proposed Fleet of Electrically-Propelled Power Boat Supplying Electric Current for Propulsion of Four Barges for Inland Waterway Transportation

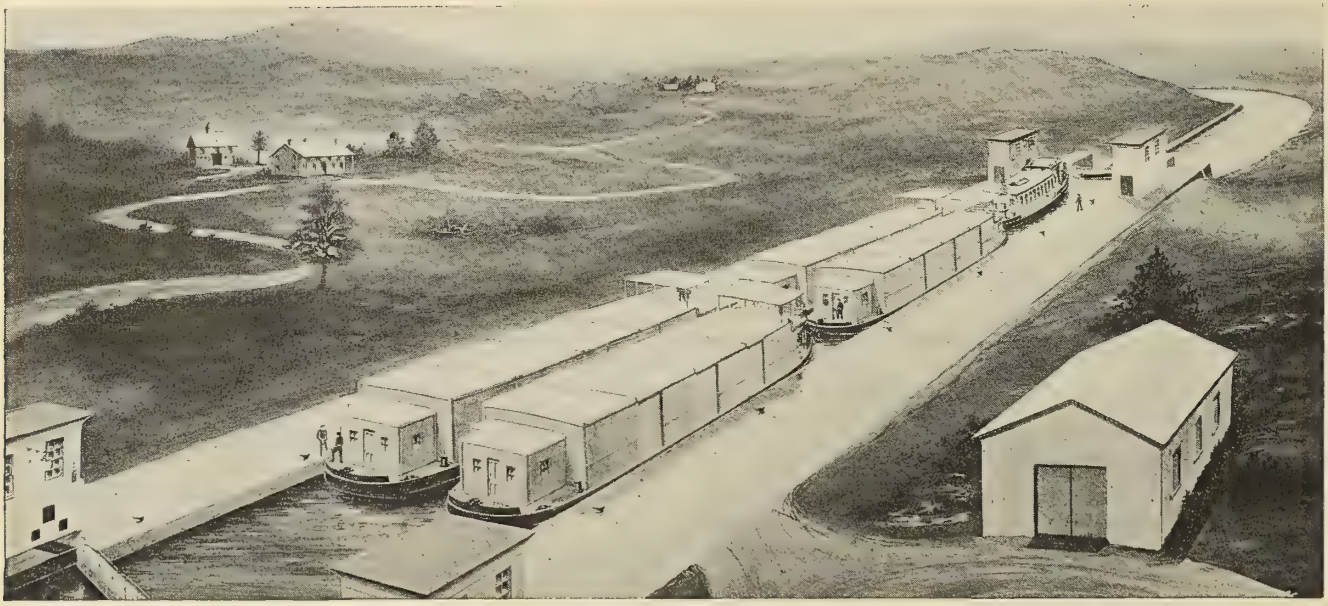


Fig. 2.—Electrically-Propelled Barge Fleet in Canal Lock

handicapped by increasing numbers of embargoes made necessary by the congestion of both tracks and terminals as well as a shortage of cars.

Proposed Freight Transportation System

In developing a new plan for the prompt dispatch of cargoes by inland water routes, a system has been proposed which no longer depends on the tow line, but uses instead fleets of separately propelled vessels traveling together in convoy, with a central electric generating station afloat connected to the fleet by cable and with all propellers driven by electric motors. All the component parts of this system have been tried out and proved practical and operative at the same high economy as central stations ashore or the multiple unit trains on the electrified railroads.

In practically all water transportation of package freight at the present time the material is delivered by a common carrier to the pier, from which it is rehandled to the barge or vessel. This carrier again delivers the packages upon another pier, piling them in the most convenient way for delivery, which is often the most inconvenient for rehandling. From this pier they are again rehandled approximately one-half to storage and one-half to immediate delivery. The storage is at warehouses, for the most part built in the congested part of a city, near railroad and marine terminals, where land is of high value.

In contra-distinction to this, the proposed method and system of transportation would function as follows:

The transportation company will receive the goods from the owner at his factory, and load them upon automobile trucks propelled by storage batteries. In this first loading, the package goods will be placed upon a movable body or truck platform. The truck will then proceed to the water terminal, it being understood that goods will not be called for at the manufacturers unless the barge for transporting them is waiting at a terminal within a distance not to exceed ten miles.

Upon the arrival of the automobile truck at the terminal, the entire load will be removed as a unit by an adequate lifting crane and placed as a unit upon the deck of the electrically propelled barge. The mechanical capacity of the terminal will be adequate to load 800 tons in four hours.

The water transportation unit will comprise four barges,

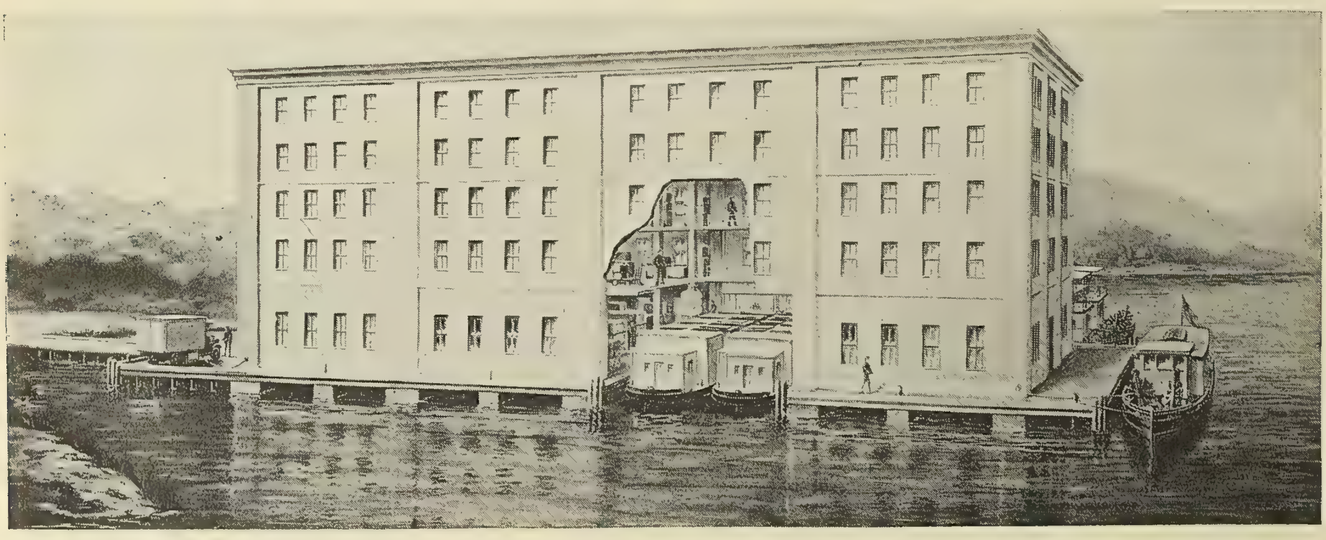


Fig. 3.—Fleet of Barges Delivering Cargo to Warehouse built on Piles Over Shallow Water. Power Boat Supplying Current for Operation of Freight-Handling Machinery in Warehouse

Fig. 4.—Proposed Barge Terminal, Showing Use of Gantry Cranes for Transferring Freight from Barges to Automobile Trucks

each having a capacity of 200 tons and provided with an electric motor and a propeller, capable of driving it at a speed of nine miles an hour in all open harbor and river waters. The power for this propulsion will be supplied by an electrically propelled vessel, carrying electric generating machinery of ample power.

Upon the arrival of this fleet at its destination, either of the two deliveries may be made. If the entire cargo is for immediate delivery, the barges will proceed to the terminal, precisely as to a loading station, there the package goods in units of automobile truck loads will be immediately transferred to electrically propelled trucks for delivery.

In the case of barges carrying goods which are not for immediate delivery, the barges will not go to the landing terminal but into a warehouse built over shallow water on submerged land. This is land of the very lowest value, upon which warehouses could be erected, fire-proof if so desired, for the least unit cost. From the deck of these barges the goods for warehousing will be lifted and placed within the warehouse at one movement, it being understood that the warehouse will absorb this cost of unloading minus the cost of hooking on which will be done by the crew of the barge.

It is to be understood that delivery will be made from this warehouse by automobile trucks propelled by electric storage batteries, the transfer of the goods to the trucks to be made in units of truck loads entirely by mechanical power.

This method of rapid and economic package freight transportation should be organized and applied first to and between the large cities on our eastern coast and to such others in the interior as are readily accessible through our leading rivers and canal systems.

Such a system is specially adaptable to a special class of large manufacturers who require the delivery of several hundred tons a week, and to classes of goods that it is entirely practical to handle in units on automobile trucks, carrying from three to five tons.

For the purpose of arriving at the comparative cost of

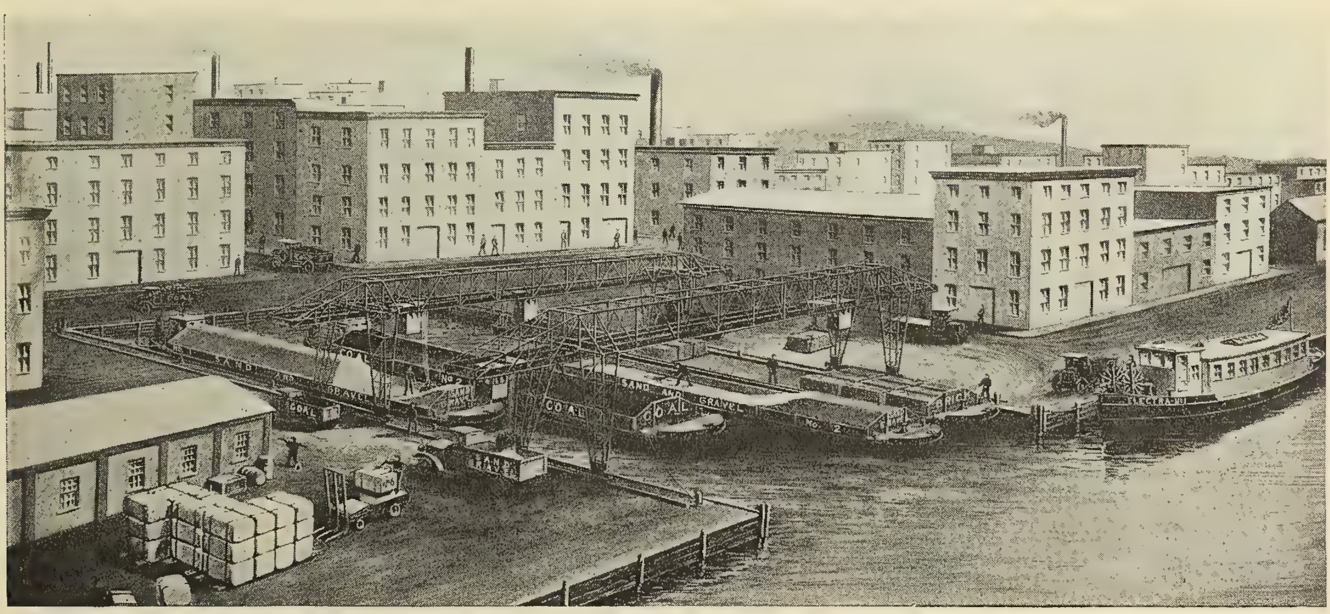


Fig. 5.—Proposed Barge Terminal for Handling Bulk Freight. Electric Current for Operating Terminal Cranes Supplied by Power Boat Moored Alongside While Barges Are Loaded and Unloaded

this method of handling cargoes, a study has been made based on the regular dispatch of 800 tons of cargo by means of four 200-ton barges and one power boat to operate between Schenectady and New York city over the Hudson river and the barge canal. This report shows the result of the investigation.

Financial Analysis of Electrically Propelled Barge Operation

Each of the four 200-ton deadweight cargo barges is 105 feet long overall, 21 feet 6 inches beam and 10 feet deep. They are built of wood, full housed and accessible both from side and overhead hatches. They are made unsinkable on the same principle as the author's yachts, *Dawn* and *New Era* (described in Marine Engineering, April, 1920), whose non-sinkability has been demonstrated. This feature avoids the large expense of marine insurance on both cargo and floating equipment, substituting therefor fire insurance, which saves at least 80 percent of this feature of operating expense.

The draft loaded is 7 feet 6 inches, while the draft loaded with the vessel water logged is 8 feet. When water logged the deck is still above the waterline, and as the motor is located in a watertight well, the barge may proceed without interruption. No salvage expense is possible and when convenient, after collision or other mishap, the barge is repaired from funds provided for maintenance, as set forth in the statement following, showing the cost of operation. Each barge is driven by a 125 horsepower electric motor, coupled to a 4½-foot propeller, and receives its supply of electricity from the power boat by a flexible cable. Comfortable living quarters are provided.

The Power Boat

The power boat is 70 feet long overall, 17 feet beam and 6 feet draft. It is equipped with four 186 brake horsepower gasoline engines, direct connected to four 120 kilowatt dynamos, which supply the electricity needed by the fleet for all purposes. The engines are not reversible, run at constant speed and operate the same as any isolated plant ashore. The control of all the propeller motors is placed in the pilot house and handled by the navigator. The power boat is equipped with a 90-horsepower propeller motor and is also made non-sinkable.

Analysis of Operating Cost

It is quite certain that the fleet of full housed barges carrying deck loads of package freight referred to in this report can be fully occupied during the time that the canal is closed by applying them to harbor lighterage, or or by operating them for transportation in southern waters; therefore no idle time is provided for in this analysis.

The following table shows the several items of expense and following the table is a résumé of how the various items are obtained.

ANALYSIS OF COST OF MOVING 800 TONS IN A FLEET OF FOUR BARGES AND ONE POWER BOAT BETWEEN SCHENECTADY AND NEW YORK AT 9 MILES PER HOUR

Total distance, 178 miles; 154 miles at 9 miles per hour; 24 miles at 4 miles per hour. Actual running time, 23 hours. Time allowed for one trip, 3 days.

	Items	Cost per Ton
1.	Cost of fuel (gasoline) per ton of cargo	$.5800
2.	Labor (crew): 7 men on power boat, 3 men on each barge; total, 19 men	.3410
3.	Subsistence	.0710
4.	Loading and unloading, cost of labor outside of boat crews	.2400
5.	Interest on investment, 6 percent per annum	.0888
6.	Depreciation of floating equipment, 5 percent per annum	.0740
7.	Repairs and maintenance, 4 percent (United States Shipping Board)	.0592
8.	Cost of fire insurance on floating equipment (1 percent)	.0148
9.	Cost of fire insurance, mixed cargo, electric machinery, at 1 percent; valuation at .20 per pound, $400 ton	.0320
	Total	$1.5008

Cost to operating company, New York to Schenectady, $1.50 per ton.

Gasoline is used for this installation partly because it can be obtained practically anywhere at any time and because the additional cost of gasoline compared with fuel oil is offset very largely by the higher cost of Diesel motors and the consequent increased interest on the investment. The labor item for Diesel engines is also higher in proportion to the higher skill necessary for their operation.

Cost of Fuel

The distance one way between Schenectady and New York City is 178 miles, of which 154 miles will be traveled at 9 miles per hour on the river using 710 engine brake horsepower. The balance of 24 miles on the canal will be run at 4 miles per hour using 117 engine brake horsepower. The actual running time will be 23 hours and the consumption of gasoline 1,366 gallons, which at 34 cents per gallon equals $464 for the cargo of 800 tons, which is at the rate of $.58 per ton for fuel.

Analysis of Labor Required

Provision is made for a total crew of 19 men (not counting families who may live aboard the barges), seven men on the power boat and three men on each barge.

The distribution of labor is provided for as follows:

POWER BOAT

One captain, at $8 per day	$ 8
Two other men who can steer the boat, at $7 per day	14
Three men, at $5 (including a cook)	15
One electrician	7
Total per day	$44

BARGES

A captain is provided for each barge, who finds at least two helpers and he is paid $350 per month, making a total of $1,400 per month for the four barges, or at the rate of $47 per day.

The basis of a trip is one day for loading, one day for transit and one day for unloading. The total labor expense for the three days as outlined above will be $273, or at the rate of $.341 per ton of cargo.

Subsistence of the crew provided for in a recent report by the United States Shipping Board allows $.86 per man per day. In the case of relatively small crews, $1 per man per day is provided. For 7 men on the power boat and 12 men on the barges, this item amounts to $19 per day, or $57 for the 3 days' trip, which is at the rate of $.071 per ton of cargo.

Loading and Unloading

It is part of the plan for the operation of the barges that the cargo shall be handled by a system of overhead cranes, which will reduce this item to not over $.10 per ton of cargo handled, but for the purpose of this analysis the common method of handling cargoes by means of hand trucks is used as a basis and at a cost of $.24 per ton handled.

Eight hundred tons off and on represents 1,600 tons handled. Assuming that half the labor will be supplied from the boat crews while in port, then half the labor cost may be added to the operating cost, or $.24 per ton of cargo for 800 tons.

Interest on Investment

It is estimated that the barges, which are of special and easy construction, can be built for $100 per ton deadweight carrying capacity, which makes a total of $80,000 for the barges. This, with $15,000 for the power boat hull and $49,000 for machinery, makes a total of $144,000 investment for floating equipment. Six percent on this amount is $8,640 per annum. Allowing 3 days for the trip, this item will be $71 for our 800-ton cargo, which is at the rate of $0.0888 per ton of cargo.

Five percent per annum is allowed for depreciation, which, based on an initial cost of $144,000, amounts to

$7,200 per annum, or at the rate of $.074 per ton of cargo.

A recent United States Shipping Board report allows 4 percent of the contract price for repairs, and on this basis our charge will be $.0592 per ton of cargo.

Fire Insurance on Floating Equipment and on Cargo

One percent per annum is allowed on the full value of $144,000 for insuring the fleet, which on the basis of 3 days for one trip, as above, amounts to $.0148 per ton of cargo.

It is assumed that a large part of the merchandise carried between Schenectady and New York will be electrical machinery and electrical supplies, and that $.20 per pound will be a conservative valuation of this kind of cargo, or at the rate of $400 per ton. A blanket fire insurance policy on this basis at 1 percent will amount to $4 per ton per annum, and for one trip of 3 days this amounts to $.032 per ton of cargo.

As shown on the below table, the total of the nine items is $1.50 cost to the operating company per ton carried.

ANALYSIS OF DISPATCH OF SHIPMENTS OF ELECTRICAL MACHINERY, ETC., BETWEEN SCHENECTADY AND NEW YORK

Routing	Car Loads Freight N. Y. C. & H. R. R. R.	Less Car Loads Freight N. Y. C. & H. R. R. R.	Express American Express Company	Motor Truck Express	Electric Motor Barge
Time in transit.....	*One Week*	*Two Weeks*	Uncertain Under Normal Conditions Deliver Next Day after Shipment	$1.00 Per Mile 5 Tons 160 Miles $160.00	One Day No Uncertainty
Cost to shipper per ton old rates.....	$3.40 Practically Cost to Railroad	$7.90	$23.00		
New rates now in force	Flat 40% Increase		Flat 12½% Increase		
Cost to shipper per ton.............	$4.76	$11.06	$25.87	$32.00	$1.50 Cost to Operator

Comparison with Other Methods of Haulage

The preceding table is the result of careful inquiry into all overland routes between Schenectady and New York. The old car load freight rate between these points was $.17 per hundred pounds, which was at the rate of $3.40 per ton and is now increased 40 percent, making the cost $4.76 per ton. The less car load rate was $.39½ per hundred pounds, which was at the rate of $7.90 per ton and is now increased 40 percent, making it $11.06 per ton.

The express rate was $1.15 per hundred pounds, which is at the rate of $23 per ton, and is now increased 12½ percent, making the cost $25.87 per ton.

A large automobile truck company recently quoted $1 per mile for 5 tons carried. The distance by good roads is 160 miles. The total of $160 for 5 tons is at the rate of $32 per ton.

The agents in New York who quoted the rate estimated delivery of car load shipments in one week; less car load, two weeks, but would make no promises. Express shipments are now taking two or more days in transit, often more.

The only certain delivery in this schedule which can be depended on is by water transportation, which requires one day for transit. The dispatch is therefore equal to express under normal conditions or motor truck, which, at best, if shipped one day might arrive the next day. The cost to the operating company is less than half the lowest freight rate.

An explanation of this amazing fact is not hard to find. A comparison was made to determine the relative amount of power required to move cargoes on the railroad and by water route.

Performance of Electric Locomotives

The electrification of our trunk line railroads for considerable distances and the use of electric locomotives for hauling freight has made it possible to obtain very accurate data on the power required to haul freight trains. In a paper read by W. S. Murray before the Franklin Institute, he related the performance of one electric locomotive of 1,400 horsepower hauling a 1,500-ton train at 35 miles per hour and two electric locomotives totaling 2,800 horsepower hauling a 3,000-ton train at the same speed. These speeds are necessary to work in between passenger trains when there is a clear track. The weight of a 50-ton freight car is 15 tons and the cargo 35 tons, so that the weight of cargo carried is as 50 is to 35. Therefore the weight of cargo carried by the 1,400-horsepower locomotive is in round numbers 1,000 tons, or 1.4 horsepower per ton carried.

An average of 560 horsepower is used by the 800-ton barge fleet, which is at the rate of 0.7 horsepower per ton carried, or just one-half the rail estimates. The above data was obtained from New York, New Haven & Hartford Railroad performance, but locomotives of much larger horsepower are required when there are steep grades to overcome. The barge route has no grades.

Since the railroads many times stated emphatically that they must have an increase of 25 percent or more in their freight rates to carry on successfully, then it would appear that the rate quoted by them before the increase was practically the cost to them of operation, including all overhead, interest charges, taxes and maintenance of way.

It can easily be seen that with power required cut in half, with maintenance of way avoided, with no land property to tax, and the inefficient tow line replaced by the economical application of electricity, the comparatively low rate of cost per ton for haulage is reasonable to expect and will very likely be still further reduced.

France Restores Her Fleet

FRANCE has made rapid progress toward restoration of her merchant marine. According to the Rapport Générale sur l'Industrie Francaise, which has just reached this country, the total French merchant tonnage on December 31, 1919, was 2,400,896 tons, or approximately the same tonnage as previous to the war, about 342,497 tons being under the Government's control. To this must be added the tonnage of the German ships provisionally under the French flag, and eventually to be permanently alloted to the several shipping companies by the Government.

Up to January 1, 1920, orders had been placed with French shipyards for the construction of 513,119 tons of ships. Since then 30,000 tons have been purchased from outside sources.

In his report to the Chamber of Deputies, Admiral Bienaimé, Deputy, asked whether or not the private French shipyards would be able to deliver, by July 1, 1922, the 669,000 tons, orders for which were contemplated. He answered the question by quoting a statement on the subject furnished him by the Minister of Merchant Marine.

This statement was to the effect that the private yards would be able to deliver the following tonnage: 1919-20, 310,000 tons; 1920-21, 445,000 tons; 1921-22, 500,000 tons, or a total of 1,255,000 tons; and, further, that at that time orders had already been placed for 729,000 tons, 215,000 tons of which were for Government account and the remainder for shipowners, leaving a construction capacity of 526,000 tons available for new orders.

Heeling Ships

BY I. C. HANSCOM

This article deals chiefly with the practical side of heeling, because some experience is needed in order to have the experiments successful, and also because few papers discuss the subject from this point of view. Co-operation in some fifty experiments is the basis of the following information; diagrams have been included to supplement the text, and through the courtesy of Naval Constructor John G. Tawresey, U. S. N., I am able to give a short description of a method, originated by him, of heeling boats and launches in the air.—THE AUTHOR.

THE amount of ballast needed for inclining a ship must be estimated approximately, and then suitable places for it may be selected on the ship. It may be located where most convenient—forward, aft or amidships. Its location does not affect the accuracy of the experiment.

Plumb lines may be hung anywhere on the ship. They do not have to be on the centerline, although it is often convenient to place them there. Long lines give better results than short ones; therefore they should be made as long as possible.

A calculation of all the dunnage on board and its center of gravity must be made; and, as it is one of the most troublesome things encountered, good judgment and care should be used. At the same time a list of all material necessary to complete the ship may be prepared. It is also necessary to have the amount and center of gravity of all liquids, and the surface of any liquids free to move.

See that there is a rowboat ready to be used in taking the draft of water, unless draft gages are fitted in the vessel.

Make arrangements for moving the ballast to and from the ship, installing plumb line frames, emptying tanks and double bottoms, handling the lines and shifting the heeling weights.

Details of Preliminary Work

Knowing the amount of ballast,* we must decide what kind to use and how to handle it in the experiment. When pig iron is employed it may be placed in piles and handled across the deck by laborers. In this case, care should be taken to have the pigs as nearly uniform in size and shape as possible, otherwise it is difficult to estimate the center of gravity. The pigs should be piled neatly and not just thrown in a heap. They may also be arranged in buckets or skips and shifted by means of a crane. Scrap iron may be used, but it is not so easy to find the center of gravity, and in some cases heeling experiments on a small scale are made on each bucket to get the center. Pigs nicely piled on heavy trucks and rolled across the deck can be used, the trucks being held by tackles to prevent their getting beyond control.

Ships have been heeled by hoisting heavy weights from floats moored alongside. This necessitates strong davits or beams lashed across the decks and projecting over the sides of the vessel, the center of gravity of the inclining weight being at the point of attachment of the falls to the davits or beams. In this case any kind of ballast may be used, only the weight of it being needed. Moving guns, boilers, men and heavy machinery, also filling and emptying tanks, are some of the more unusual methods of heeling.

Plumb lines are usually hung in the hatches, because longer lines can then be used. They should swing free and not rub against anything. Light wooden battens are tacked to a frame fastened in the hold to mark the swing of the plumb lines. These battens should just clear the lines and be long enough to take the greatest swing of the bobs. Each batten may be marked "Port" and "Starboard," for in most cases the battens are removed to the office and measured there, and it is necessary to know which swings are to starboard and which to port. Sometimes tee squares are made reaching from the upper deck to the hold to support the bobs and are quite elaborate and costly, but ordinarily a wooden beam across the hatch and a frame down below is sufficient. If the heel of the vessel before the experiment starts is wanted, a line parallel to the centerline of the ship must be marked on the frame supporting the plumb line (see diagram Fig. 6). Practically all that is needed is a mark on the removable batten in the hold, the same distance from the centerline of the ship as the hook or nail which supports the plumb line.

The weight of the dunnage is usually estimated, for it can rarely be weighed. For this reason it might be wise to take that part of it first, the weight of which is fairly well known, and then collect any information obtainable on the rest. Even then, the man making the calculations is apt to wonder if the weights have been over or under estimated all through.

To get the weights necessary to complete the vessel, one must have a list of everything on board when she is finished. In case the ship is new, a book of specifications is the best thing, the items being checked off as the work proceeds. Getting the weight of the water and oil is not very hard, if the tanks and double bottoms are full, but if only partially filled, which is usually the case, it makes a lot of work. In a large ship with a rather flat bottom, the surface of the liquid in a tank, which has only four or five inches of water or oil in it, cannot be taken from the plans with satisfaction. It is well to remember that the workmen in the yard do not, as a rule, take measurements as closely as men in the office. For instance, in sounding a tank or double bottom compartment, they very often take the nearest inch as being close enough. Sometimes they will call a tank empty which has three inches of water in it.

The water in the machinery and boilers must not be overlooked, nor must the cylinder and lubricating oil be forgotten. There should be an examination of the paint and oil rooms and the storm oil tank, as well as the fresh and salt water systems and any gasoline which may be stowed on deck.

Unless the vessel is fitted with gage glasses for reading the draft of water, a rowboat should be ready for this purpose. If the ship is listed, the draft should be taken on both sides, then the mean of the readings will be the draft.

Allow several days for the mopping up of the tanks, if that work is to be done. It will be well to make sketches of the plumb bob frames for the carpenters, then they will know just what is required and the man in charge will get what he wants. If the ballast is to be man-handled across

* See any good text book on naval architecture.

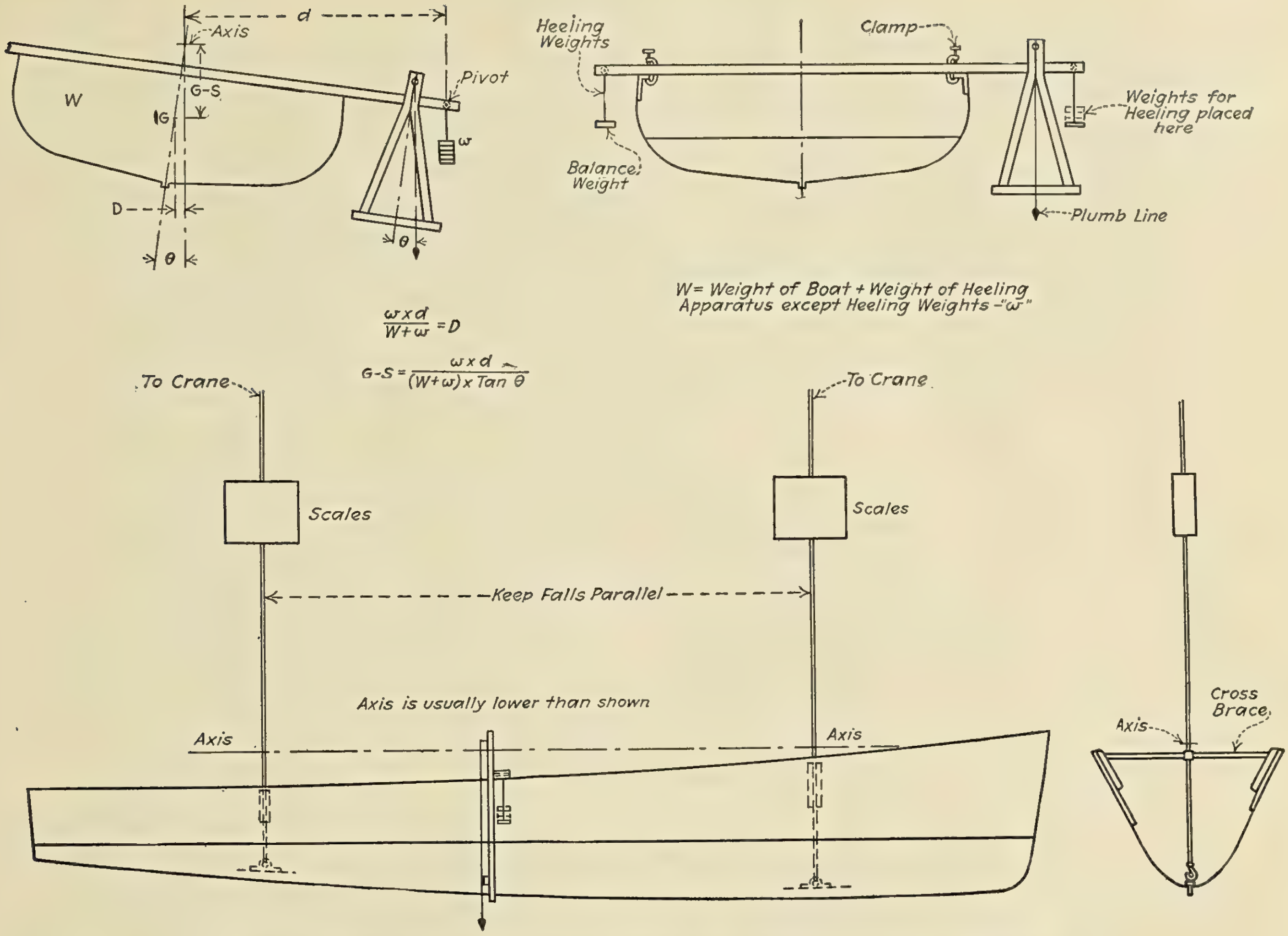


Fig. 1.—Diagram Showing Method of Heeling, Boat Acting as Weight of Pendulum

the deck, care should be taken to have enough men to move it quickly.

The Inclining

Everyone not actually engaged in the experiment should be ordered off the vessel and all those on board should be weighed. The weighing can be done while the draft of water is being read, then the weight of the observer may be taken. The fore and aft centerline of the ship should be marked on the deck with chalk, and the workmen should stand on this line during the reading of the plumb lines.

The men who are at the plumb bobs should be instructed how to mark the battens, so that number one reading, for instance, will be on each batten and denote the result of moving weight number one a certain distance across the deck. While the men are being instructed and are taking their places, the gangplank may be removed and some laborers stationed ready to slack off all lines from the ship to the wharf when the order is given.

At this stage of the heeling the conditions should be about as follows: The ballast should be in place ready to be moved; down in the holds the men should be at the plumb lines, one man at each line, ready to take readings; the gangplank should be removed and the men who are to slack off the line should be at their posts. The rest of the laborers should be near the ballast, ready to move it at the given signal.

The man in charge of the experiment should be where he can best see all the operations and can quickly receive the reports from his subordinates. He usually has a couple of draftsmen who call down to the men at the plumb lines when they are to take readings, and also measure the distance the heeling weights are moved and their centers of gravity above the deck.

The foreman of the laborers should be nearby the man in charge, so that he may transmit the orders to his men quickly. The first order should be to slack away all lines. When this is done, the next should be to mark zero number one on the plumb line battens (there may be more than one zero mark). Next, the slack should be taken in on the forward and after lines, one line forward and one aft is usually sufficient. Then the ballast should be shifted and frequent inquiries made of the men at the bobs as to how far they have swung. When about three inches of heel has taken place, the laborers at the weights may stop and return to the centerline of the ship, and a record may be made of the distances the weights were moved and their centers of gravity above the deck. The hawsers should now be slacked off forward and aft and another reading taken on the battens, which may be marked number one. The men at the plumb lines should be cautioned not to mark the battens while the ship is rolling, which often happens just after the weights are moved, but to wait till she steadies down.

When all the battens have been marked, the slack of the forward and after lines may be taken in, the weights moved again and new readings taken. The rest of the experiment is simply handling the lines, moving the ballast and taking readings at the plumb lines.

Duties of Man in Charge of Heeling

In taking charge for the first time, it would be well to write in a notebook the things that are to be done, in their proper order. The list may be checked up before the inclining takes place, to see if anything has been omitted. It may prevent the mortification of having ordered the zero points to be marked on the battens before the lines

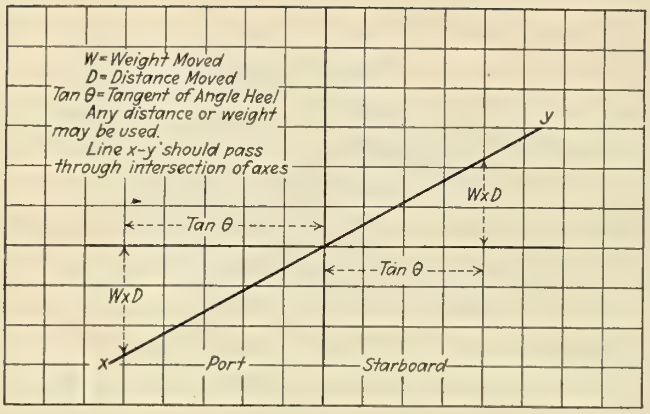


Fig. 2

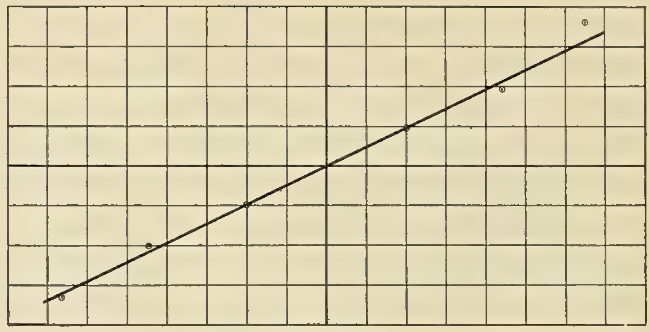


Fig. 3

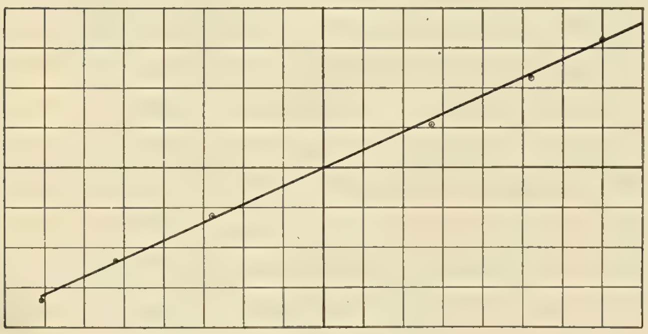


Fig. 4

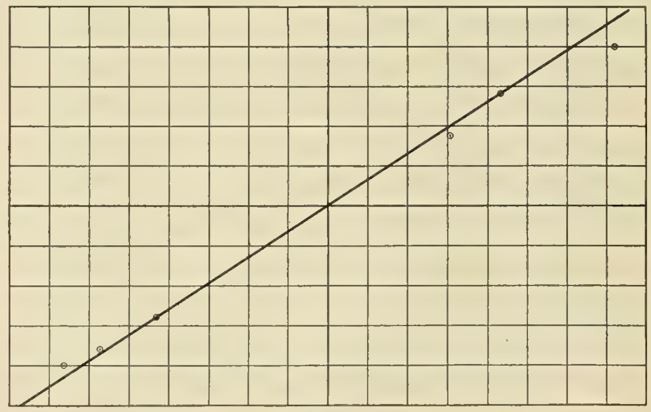


Fig. 5

have been cast loose. Other things should be written in the book such as a general description of the condition of the ship at the time of heeling; the size, number and location of the hawsers; the condition of the double bottom, tanks, peaks, water in the boilers and machinery, if any; the time of day, draft of water, density of water, amount of wind, condition of tide, number of men on board with their weight and where they are stationed—in fact, everything which affects the experiment except the dunnage and the detailed calculations of the liquids, which had better be separate.

Difficulties Likely to be Encountered

Pig iron varies considerably, and unless care is taken to pick out pieces weighing about the same amount it is hard to estimate the center of gravity when the iron is placed in piles. When buckets are filled with iron it is troublesome to find the vertical center of gravity. As a matter of fact, it is guessed in most cases. Perhaps no great error occurs, but it is better not to do this.

The heeling weights are apt to be late in arriving at the ship. Why they are the writer does not know, but in a majority of cases this occurs. The ballast should be weighed some time before the experiment, as the scales may break at the last moment.

Not enough time may be given the carpenters for making and installing the frames for the plumb lines, particularly if the list of the ship is required, for in that case slight changes in location of the frames may be necessary after they have been fastened in place.

Cleaning out the double bottom tanks or peaks is bothersome to the men and is likely to be slighted. Many times they cannot be entirely cleared and estimates must be made for free surface of liquids. It is better for the operator to put on overalls and rubber boots and make sure what the conditions are.

The water in the machinery, boilers and fresh and salt water systems should be checked up just before heeling, because they are subject to changes at short notice.

Sometimes the experiment has to be made when a strong wind is blowing, which prevents slacking off the hawsers, or there may be unavoidable delay, resulting in heeling the ship in a strong tide. Where no draft gages are fitted,

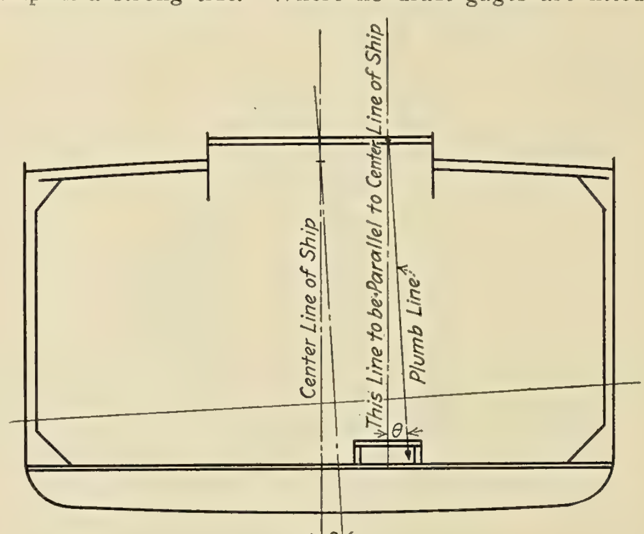


Fig. 6

waves may make the reading of the draft of water uncertain. The results depend on so many men that there is pretty sure to be something wrong, unless extreme care is taken to follow up every order and see that it is being carried out.

Naval Constructor Tawresey's Method of Heeling

Naval Constructor John J. Tawresey, U. S. N., designed an apparatus to be fastened to a boat in such a way that the boat became the weight at the bottom of a pendulum. This pendulum, instead of having one rod supporting the weight, had two—one forward and one aft. These rods were adjustable both vertically and athwartships, so that the axis of rotation might be parallel to the waterline or the bottom of the keel in a fore-and-aft line, and exactly amidships in the athwartship direction. A beam was clamped across the boat amidships, Fig. 1, and ordinary iron weights such as are used on scales were placed on a hanger at either end. The beam was made to project over the boat more on one side than the other, to allow a tee square to be fastened to it for hanging the plumb line.

Two traveling cranes, each having a heavy pair of scales attached, picked up the boat. Reading the scales at each crane gave the weight of the boat and allowed for fore-and-aft position of the center of gravity to be determined, correction being made for the weight and position of the heeling apparatus. The heeling was done by putting weights on the hangers of the beam carrying the plumb line. The result of the heeling was the distance from the center of gravity to the axis of rotation.

The advantage of this method is the ability to get the absolute weight and center of gravity of the boat, both vertically and longitudinally. Undoubtedly it is the most accurate way of heeling yet devised. It is limited to the size and weight of boat which can be hoisted in the air. Fig. 1 gives a general idea of the arrangement. The heeling apparatus shown in Fig. 1 has been improved by Naval Constructor Tawresey, but the principle is the same as that shown.

Conclusion

It is evident that considerable work has to be done before the actual inclining takes place; moreover, unless this work is done properly the results of the heeling may be impaired.

Experiments vary because conditions vary—not only in different yards, but in the same yard—and no two ships are in precisely the same condition when heeled. The kind of ballast on hand at the time may determine the method of inclining, and the man in charge adopts what seems to him the proper arrangement.

Most heeling experiments are conducted under more or less adverse conditions, and the results are usually approximate, but close enough for practical purposes. Indeed, it is a question, apart from ascertaining the actual center of gravity of the ship, whether the results with some free water on board are not more reliable than when the vessel is heeled dry.

As an aid in determining which readings of the plumb lines are correct and which are incorrect, Fig. 2 is appended, and examples of its use are shown in Figs. 3, 4 and 5. Fig. 6 shows a particular case in hanging plumb lines.

Shipbuilding Economies

(*Concluded from page 879.*)

burned. Excellent results can be obtained with oil forges if the rivet heater is skillful, as the temperature of the heating chamber can be accurately regulated and the rivets in the heater are in plain view. An experienced heater can tell at a glance when the rivets are hot enough to drive.

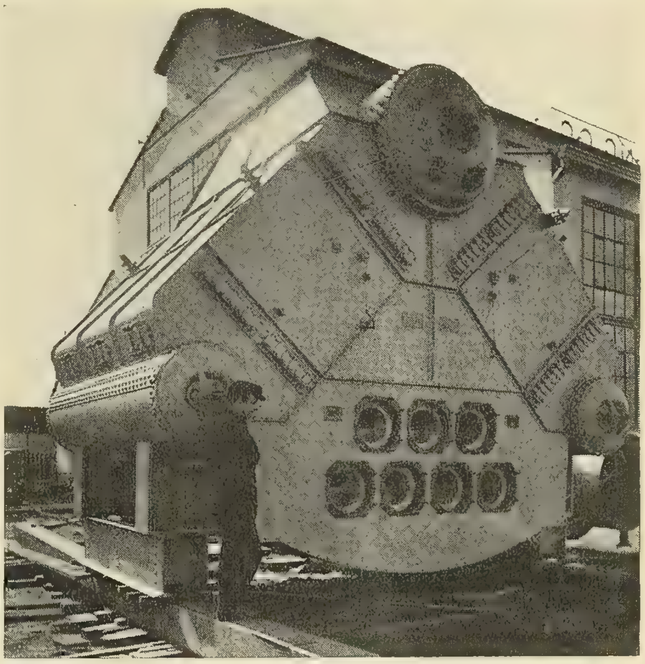
Coal forges are not used at the Puget Sound yard because the coal available in this locality clinkers so badly that fires must be cleaned at least twice a day. This delay is fatal to efficient riveting.

Coke forges similar to that shown in Fig. 22 are the most satisfactory fire for rivet heating, in the opinion of this navy yard. The coke is purchased already broken into nut size so that there is a minimum of labor in connection with its utilization, and the fire has to be deep in order that there will be sufficient "volume" of heat.

Ludlum Marine Watertube Boiler

Built for the United States Naval Experimental Station at Annapolis, Md.

Of special interest, because of its large size and extremely high pressure, is the boiler illustrated, which is 15 feet high, 17½ feet wide and 12 feet deep, with a furnace volume of approximately 500 cubic feet. Its weight is 85,000 pounds complete. The boiler was built for a working steam pressure of 350 pounds per square inch and tested to 550 pounds hydraulic pressure. The steam drum is 48 inches by 12 feet, with a tube sheet



Ludlum Watertube Boiler, Built to Carry 350 Pounds Working Pressure

1 13/16 inches thick. The water drums are 30 inches by 12 feet, with tube sheets 1 13/16 inches thick. All drums have double butt strap and double riveted joints.

The tubes are of cold drawn seamless steel, No. 10 gage, 1⅝ inches outside diameter. Surrounding the boiler is a casing of No. 10 gage steel plate backed with asbestos mill board and 2 inches of high-tempered special insulating material. The combustion chamber has a 9-inch fire brick lining backed up with the same insulating material mentioned above. The bottom of the furnace is shaped on the arc of a circle to allow for the proper expansion of the brick lining.

The unit is equipped with cleaning openings for each bank of tubes and also with Ludlum automatic soot blowers, the latter being operated by a chain pull. They automatically dispose of water of condensation in the piping and also shut off the steam automatically after cleaning is completed.

This boiler was too large to be shipped by rail and it was therefore transported on a barge, completely assembled. On arrival at the Naval Station it was necessary only to set it on its foundation and connect up the piping and smoke stack. No mason work or boiler setting was required.

This equipment was built in the shops of the New York Engineering Company at Yonkers-on-the-Hudson, New York, where a battery of boilers of this same type is now under construction for the United States Navy, each unit of which will be much larger than the one here described. When completed, they will be installed in one of the new battleships now under construction.

General Formulae for the Vertical Position of the Center of Buoyancy

BY L. PISTNER, C.E.

THE necessity for a rapid determination of the vertical position of the center of buoyancy frequently arises. For this purpose Normand's, or, as it is sometimes called, Morrish's formula, is generally used. This formula is:

$$Z_0 = d - \tfrac{1}{3}\left(\frac{d}{2} + \frac{V}{A}\right),$$

in which

Z_0 = height of center of buoyancy above the under side of flat keel, in feet.
d = mean draft in feet to load waterline.
V = volume of displacement to load waterline, in cubic feet.
A = area of load water plane, in square feet.

It was this formula which served as the basis for the relations between beam and metacentric height established by F. M. Hiatt in the July, 1920, number of MARINE ENGINEERING. In the latter article it was stated that the formula had been applied to a large number of ships and found to yield very accurate results, the error usually being less than one-tenth foot and seldom greater than two-tenths foot.

It is the intention in the present article to develop formulae covering the extremes of cases to be met with in practice and to indicate the range of error to be expected from the application of Morrish's formula to these extremes.

Referring to Fig. 1, consider in the general case the forward body referred to the axes X, Y, Z (X and Y being in the horizontal plane and Z at right angles to this plane), AOB being the maximum midship cross-section, ABC the water plane section, and the curve OC the under side of keel and stem.

The case shown represents one extreme in which there is no parallel body whatsoever. The opposite extreme is evidently that of parallel body continued throughout the entire length. For this extreme case Morrish's formula gives:

$$z_0 = d - \tfrac{1}{3}\left(\frac{d}{2} + d\right) = \frac{d}{2},$$

since $\dfrac{V}{A} = d$ for a rectangular solid, which result is *exact*.

It is now required to derive an expression for the vertical position of the center of buoyancy for the case of the figure. In order to permit of algebraic treatment it will be necessary to assign to the curves of keel, load waterline and midship cross-section, that is, to OC, AC and AO respectively, equational relations by means of which these curves may be referred to the axes of reference. For our purpose it will be assumed that these curves are *parabolas*, the vertices of which are located at points O and A; that is, the tangent to OC at O will coincide with the X axis, while the tangents to the load waterline at A and B will be parallel to the X axis.

It will be understood that the choice of the parabola for this purpose is a matter of convenience in calculation and that such choice in no sense invalidates the generality of the method. Any other curve satisfying the necessary conditions as to tangency and passing through the designated points would have delineated the surfaces equally well, but would have led to unduly cumbersome algebraic work. For this reason the parabola was chosen.

Since OC is a parabola, its equation may be written:

$$z = K_1 x^2,$$

where K_1 is determinable from the condition $z = d$, $x = L$, whence

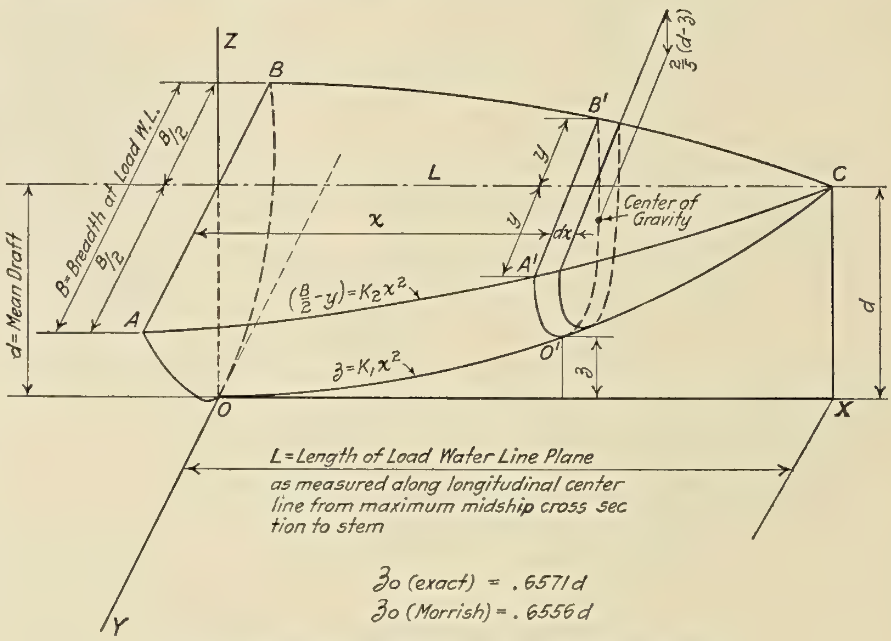


Fig. 1.—Forward Body, Convex Surfaces Throughout

$$K_1 = \frac{d}{L^2}.$$

Similarly for AC,

$$\left(\frac{B}{2} - y\right) = K_2 x^2,$$

where

$$K_2 = \frac{B}{2L^2},$$

since $y = 0$ when $x = L$. Considering now any cross-section $A'\ O'\ B'$ distant x from the midship cross-section, the area of the former may be written:

$$\tfrac{2}{3} \cdot 2y \cdot (d - z),$$

since the area of a parabolic segment is equal to two-thirds the product of the width and height.

The center of gravity of a parabolic segment being three-fifths of the total height from the vertex, the lever arm of the area with respect to the X axis becomes:

$$z + 3/5\ (d - z) = 1/5\ (2z + 3d).$$

The moment of differential slab of base $A'\ O'\ B'$ and of thickness dx about the X axis may then be written:

$$dM = \tfrac{2}{3} \cdot 2y \cdot (d - z) \cdot 1/5\ (2z + 3d) \cdot dx,$$

and

$$M = 2/15 \int_0^L 2y \cdot (d - z) \cdot (2z + 3d) \cdot dx,$$

whence we obtain as an expression for the vertical height of the center of buoyancy above the X axis:

$$z_0 = \frac{M}{V} = \frac{2/15 \int_0^L 2y \cdot (d - z)\ (2z + 3d) \cdot dx}{\tfrac{2}{3} \int_0^L 2y \cdot (d - z)}.$$

Substituting values of Z and Y in terms of X, and values of K_1 and K_2 in terms of B, L and d, expanding and performing the indicated integrations, we obtain:

$$z_0 = \frac{2/15 \cdot 184/105 \cdot Bd^2L}{\tfrac{2}{3} \cdot 8/15 \cdot BdL} = 23/35d = \underline{\underline{.6571d.}}$$

Now applying Morrish's formula to this case, we have, since

$$V = \tfrac{2}{3} \cdot 8/15\ BdL$$

and

$$A = \tfrac{2}{3}\ BL,$$

$$\frac{V}{A} = 8/15d$$

and

$$z_0 = d - \tfrac{1}{3}\left(\frac{d}{2} + 8/15d\right) = 59/90d = \underline{\underline{.6556d.}}$$

from which it is seen that for the extreme case of no parallel body, but with convex surfaces throughout, Morrish's formula yields results the error of which does not exceed .0015*d*. For a draft of 30 feet the error is less than ⅝ inch as far as convex forebody is concerned. But it was previously shown that Morrish's formula gives an *exact* result for the limiting condition of a rectangular form. It follows, therefore, that for all forms to be met with in practice, varying between parallel body and no parallel body, the error due to the use of Morrish's formula will not exceed .0015*d*, provided only that all surfaces are convex.

It remains, therefore, to consider the effect of concave surfaces as modifying the above conclusion. The concave surface is exemplified by the hollow *run* in most ships and by the hollow *entrance* less frequently.

Referring now to Fig. 2, in which CD is the sternpost, AOB the maximum cross-section of concave lines, and $A'\ O'\ B'$ a cross-section intermediate between the latter and the sternpost, and taking AO and OB as parabolas with vertices at O and AC and CB with vertices at C, we obtain by a method entirely similar to that already presented:

$$Z_0 = \tfrac{3}{4}d = .7500d \text{ by the exact method,}$$

and

$$Z_0 = 13/16d = .7222d \text{ by Morrish's formula,}$$

from which it is seen that for the case of concave surfaces there is a maximum error of .0278*d* by the use of Morrish's formula.

Considering all types of merchant and passenger ships, it will be found that the volume displaced by those underwater sections of the hull which are *wholly concave* bears to the volume displaced by those sections which are either straight line or wholly convex, a ratio which never exceeds 1:6. For such ships as a whole, therefore, the maximum error resulting from Morrish's formula will be:

$$(.0015d \cdot 6 + .0278d \cdot 1) \div 7 \cdot .0053d,$$

which for ships of 30-foot draft is *less than 2 inches.*

This error is probably less than that to be expected in ordinary forms of computation unless extraordinary precautions are observed. It is therefore suggested that Morrish's formula may with propriety be used for final as well as preliminary work.

In closing it may be stated that the method here presented of approximating the lines of the hull by parabolic segments, the parameters of which are determined by the limiting conditions of tangency and general dimensions, will be found extremely useful in a large number of practical as well as theoretical problems, as, for example, in determination of volumes of fore and aft peak tanks, transverse and longitudinal metacentric height, etc. The results obtained will be found surprisingly accurate.

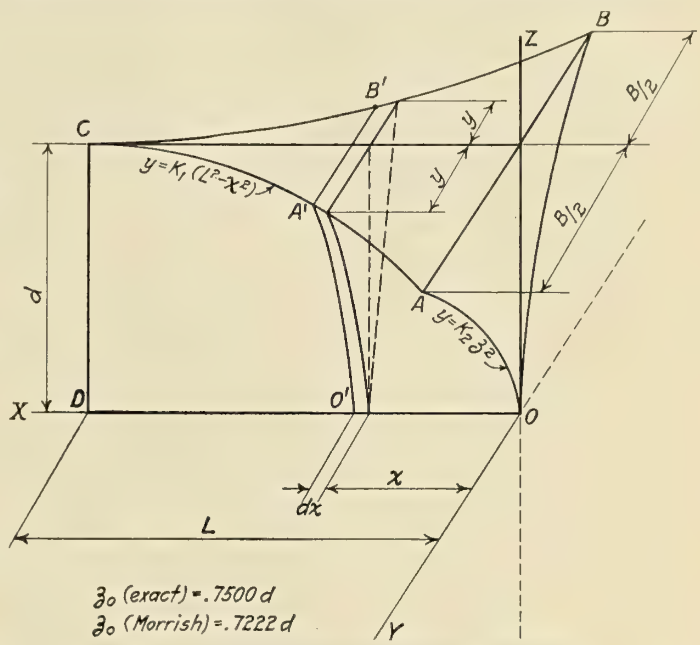


Fig. 2.—After Body, Concave Surfaces Throughout

S. S. Belgic to Enter Belgian Passenger Service

BERTHED at Pier 61, North River, New York, recently was the world's largest freighter, the *Belgic*, of the International Mercantile Marine Company's fleets. The *Belgic's* deadweight capacity is something more than 22,000 tons. She is 670 feet long and 78 feet beam. Her registered tonnage is 24,547 gross and she burns oil. Designed as a combination passenger and freight carrier of the Red Star Line's service between New York and Antwerp, and built at Belfast, the *Belgic* was finished up hastily in 1918 and rushed into service as a trooper. Since the close of the war she has been operated under the White Star flag.

It is stated that she will soon be taken in hand for completion as originally designed, by the addition of two decks to embody the latest features in passenger carrying equipment, and that as the *Belgenland* (her original name) she will be put into the Red Star Line service when the work is completed. She will be the largest ship to ply to a Belgian port.

PHILADELPHIA MARINE EXPOSITION.—The American Marine Exposition will be held in the First Regiment Armory, Philadelphia, March 14-19, 1921, under the management of the American Exposition Company, 803 Real Estate Trust building, Philadelphia.

The Effects of Holes, Cracks and Other Discontinuities in Ships' Plating*

BY PROFESSOR E. G. COKER, D. SC., F.R.S., AND A. L. KIMBALL, M.E.E.

THE present paper is an extension of the subject matter of two former papers† in the Transactions of the Institution of Naval Architects, in which the effects of various discontinuities were examined to find the alteration in the stress distribution produced thereby, principally in tension members. It confirms, in general, some of the principal results of the mathematical theory of the stress around an elliptical hole in a wide plate, which formed the subject matter of a paper‡ by Professor C. E. Inglis contributed in 1913. Viewing a crack as the limiting case of an ellipse, in which the minor axis is vanishingly small, it is easy to show, both from calculation and experiment, that a crack inclined to the direction of stress produces a great concentration, which approaches an infinite value. A practical way of reducing the stress intensity is to drill out the ends of the crack, and the experiments described here show what effect this produces, and also the change in stress produced, by forming elliptical cavities at the ends instead of circular holes.

At the date of the earliest of the papers mentioned above the stress which occurs in deck plating at a hatchway was also examined, but only for the purpose of determining the stress across the weakened principal section, whereas the principal point of interest arises at the change of section of which some measurements are now contributed, to show how great is the stress experienced at the joint of the diminished section to the main body of the member.

The experimental methods used have been sufficiently described before, and it is, therefore, only necessary to recall that the complete determination of stress in a plate subjected to loading in its own plane can be completely solved experimentally without reference to any theory of stress distribution, provided it may be assumed that the plate is not so thick as to cause a variation of stress across the section, and for applications to other materials that load systems applied to each edge boundary are in equilibrium separately, as is the case in all the examples described here.

If these simple conditions are fulfilled, the solution of any stress problem at a point in a plate, whatever may be its form, can be determined by three sets of measurements. There are:

(1) The directions of the principal stresses P and Q.
(2) The value $(P - Q)$ from an optical measurement.
(3) The value $(P + Q)$ by a mechanical measurement.

It is possible, however, to dispense with the third measurement in a complete solution, but it is generally more convenient to obtain this. In many practical problems, however, one or more of these measurements can be dispensed with. For example, at a point along a boundary where there is no applied load, the values of $P \pm Q$ reduce to either P or Q, since the other stress must be zero, while the direction of the existing stress is along the boundary.

This latter case gives an important simplification, since in many instances the only important stress is at a boundary.

An interesting example is presented by the case of an elliptical hole in a plate in which the ratio of the length $(2a)$ of the major axis to the length $(2b)$ of the minor axis is varied between equality and infinity giving a circle for one limit and a fine crack at the other.

It is not proposed to consider circular holes here, except incidentally, as these have already been examined with some care. The case of the elliptical hole has not been examined experimentally so far as we are aware, although an exact solution is known for such a hole in an infinitely wide plate. In order to verify this theory, various elliptical holes were cut in a plate of clear nitrocellulose 5 inches wide and 0.155 inch thick, to which a uniform tension load was applied in a testing machine of three tons capacity. The arrangement for loading the test piece is of the simplest kind, Fig. 1, and consists of a pair of plates A secured to each end by a number of small pins B to distribute the pull applied by the machine through centrally placed pins C. The positions of the holes cut in this plate are indicated approximately in this figure.

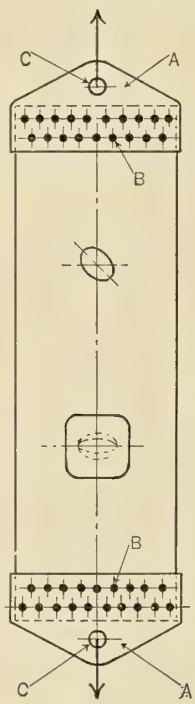


Fig. 1

In such an arrangement nearly the whole length of the uncut plate should be in pure tension, and this was found to be so, by optical measurements, except for a short distonce from the ends.

It was considered sufficient to examine three cases of elliptical holes, and these were selected somewhat arbitrarily by taking an ellipse with a major axis 1.125 inches long perpendicular to the line of pull, and having a minor axis 0.375 inch. This hole was subsequently altered to one with major axis 1.2 inches, and the minor axis was increased to 0.8 inch. In a third example this latter form of hole was intended to have the major axis at 45 degrees to the line of pull, but through an error in cutting out this line was found to have an inclination of 49 degrees to the line of pull, and was therefore somewhat inconvenient for calculation purposes. For convenience of reference in all these cases, any point A, Fig. 2, on the boundary of these holes is determined by means of the eccentric angle β for a circle described on the major axis as diameter. It will be convenient to describe the earlier experiments on an elliptical hole athwart the line of pull by reference to the less eccentric one first, although, as mentioned above, the

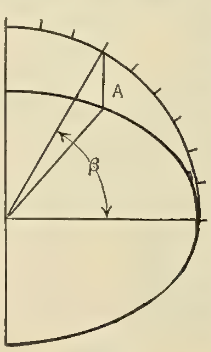


Fig. 2

* Paper read before the Institution of Naval Architects, March 25, 1920.

† E. G. Coker: "The Determination, by Photo-Elastic Methods, of the Distribution of Stress in Plates of Variable Section, with Some Application to Ships' Plating," Transactions of the Institution of Naval Architects, 1911. E. G. Coker and W. A. Scoble: "The Distribution of Stress Due to a Rivet in a Plate," Transactions of the Institution of Naval Architects, 1913.

‡ C. E. Inglis: "Stresses in a Plate Due to the Presence of Cracks and Sharp Corners," Transactions of the Institution of Naval Architects, 1913.

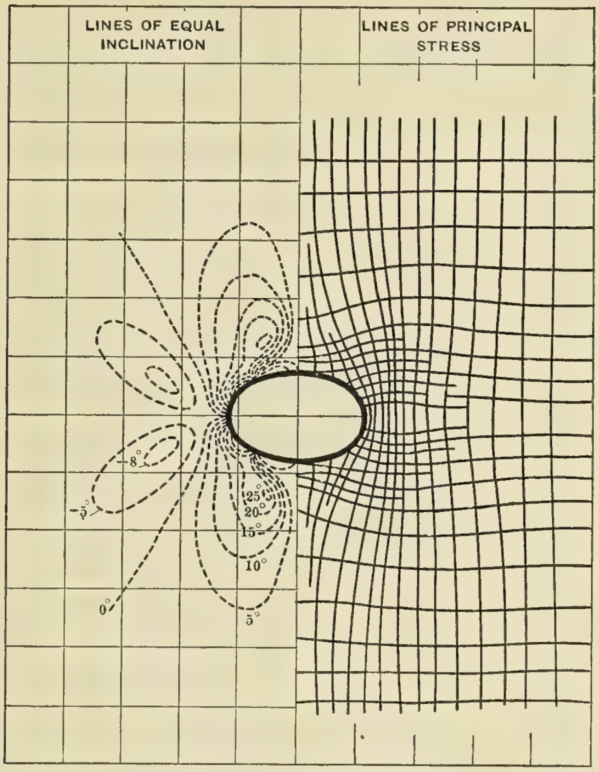


Fig. 3.—Elliptical Hole $\frac{b}{a} = \frac{2}{3}$

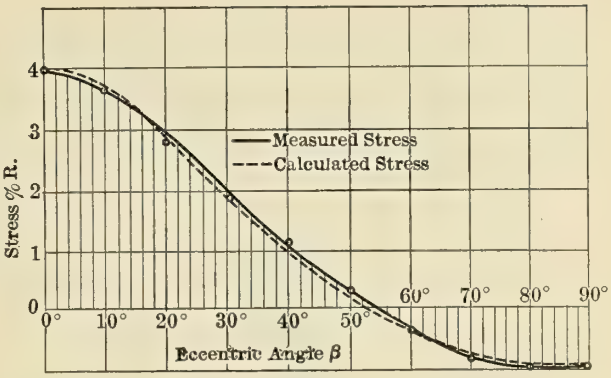


Fig. 4.—Stress at Boundary of Elliptical Hole, Case $\frac{a}{b} = \frac{3}{2}$

experiments were made in the reverse order to economize skilled workmanship and material. The general features of the stress distribution are apparent at once in the polariscope, the effect of a pull being to cause an intense stress at the ends of the major axis, and if the elliptical hole reduces to a fine slit, the region around the ends of this latter becomes very much overstressed at even a small load, and shows this on removal of the load by characteristic residual stress effects. It is also to be noticed that the directions of greatest stress intensity away from the hole approach the boundaries at a considerable angle to the axial line, and this leads to the belief that in a plate of narrow width the stress at the outer straight boundaries will be found to reach a maximum at two places equally distant from the line of minimum cross-section. An examination of a plate with an elliptical hole in it of considerable size shows this to be the case and confirms some recent measurements of the effects of moderate-sized circular holes in tension members.* Apparently the stress at the minimum section of this latter member has, in general, maximum values at the inner boundary and minimum values at the outer one. In the elliptical hole the same effect is noticed, and is probably connected with the fact that in such a case the lines of principal stress, having a general direction parallel to the line of pull well away from the hole, curve first one way and then the other as they get farther from the hole, so that there must be a change in stress at the boundary if this latter is only a finite distance away. This effect is noticeable even in the present case, and the lines of principal stress, determined experimentally and shown in Fig. 3, exhibit this clearly. The lines of equal inclination, from which these curves are derived, are also marked on the left-hand side of the diagram. An examination of the stress at the elliptical boundary shows that its variation is very great. Commencing at the extreme end of the major axis, where the tensile stress is most intense, Fig. 4, it gradually diminishes to zero at a point having an eccentric angle of 54 degrees, and becomes a compression stress which reaches a maximum at the end of the minor axis.

A comparison of these observed stresses with the calculated values obtained from the appropriate equations of Professor Inglis's paper shows a gratifying agreement, as the figure shows, and affords a proof, if any were needed, that such calculations can be applied to any material which obeys the assumptions on which the mathematical theory of elasticity is based.

* E. G. Coker, K. C. Chakko and Y. Satake: "Photo-Elastic and Strain Measurements of the Effects of Circular Holes on the Distribution of Stress in Tension Members," *Transactions of the Institution of Engineers and Shipbuilders in Scotland,* November, 1919.

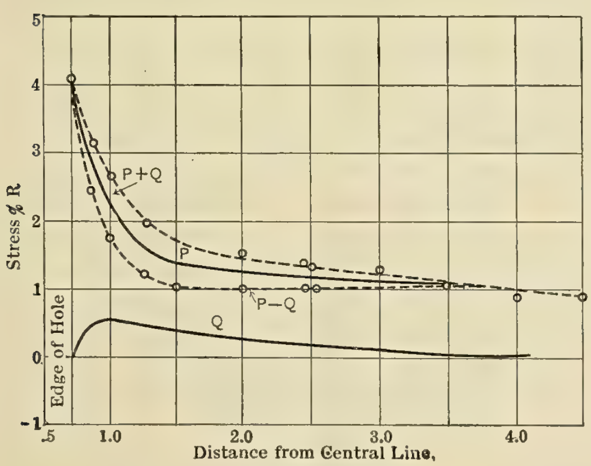


Fig. 5

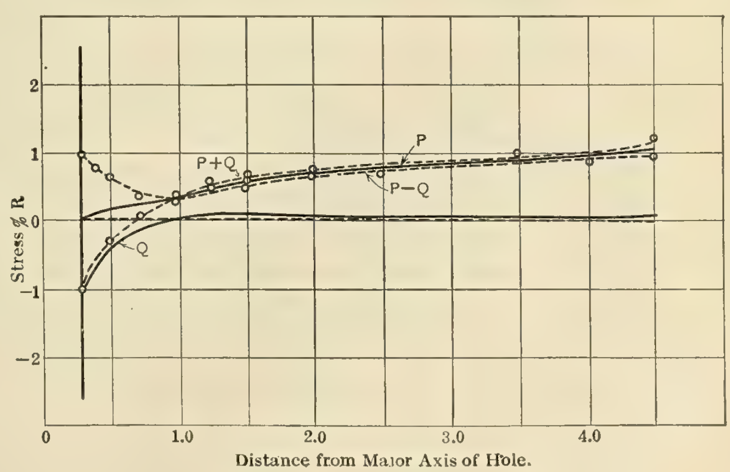


Fig. 6

The distribution across the minimum section necessitates a complete analysis, which is provided by the curves of Fig. 3, together with the values of $P \pm Q$, expressed in terms of the appropriate mean stress R corresponding to an infinite plate, as shown on Fig. 5. The values of P and Q have been separated from these observations, and are

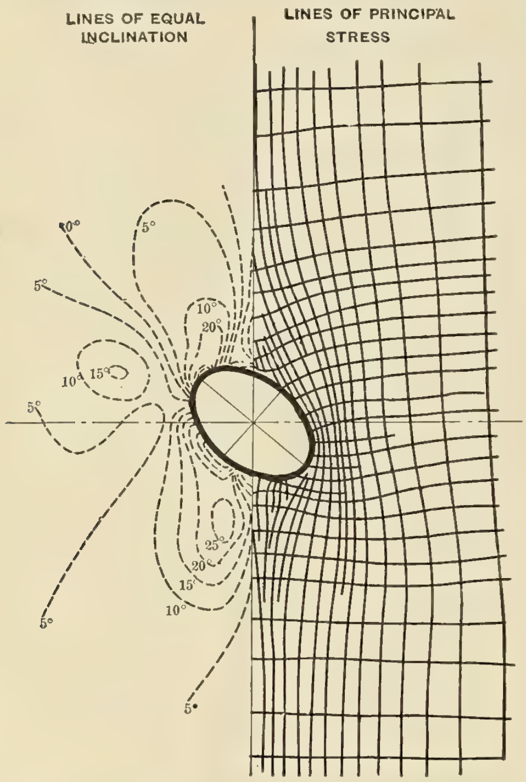


Fig. 7.—Elliptical Hole $\frac{a}{b} = \frac{3}{2}$. Inclination 49 Degrees to the Line of Pull

shown by firm lines. It will also be noted that in addition to the great intensity of the tension at the inner point of the boundary there is a perceptible tensional cross stress near the edge, and as the ellipse tends more and more towards a fine horizontal crack, the maximum value of Q increases and also approaches the boundary, although it can never actually reach it in any practical example.

It is interesting to trace the variation of stress along the central axis by observations of the values of $(P \pm Q)$ obtained in a like manner, and these latter are shown in Fig. 6, from which it will be observed that the axial stress is zero at the boundary of the hole and rises gradually to a constant value at a distance of about two inches away, while the cross stress is a compression approximately equal in value to the corresponding uniform tension, which rapidly changes to a small tension and ultimately disappears.

The case of the more elliptical hole also bears out these

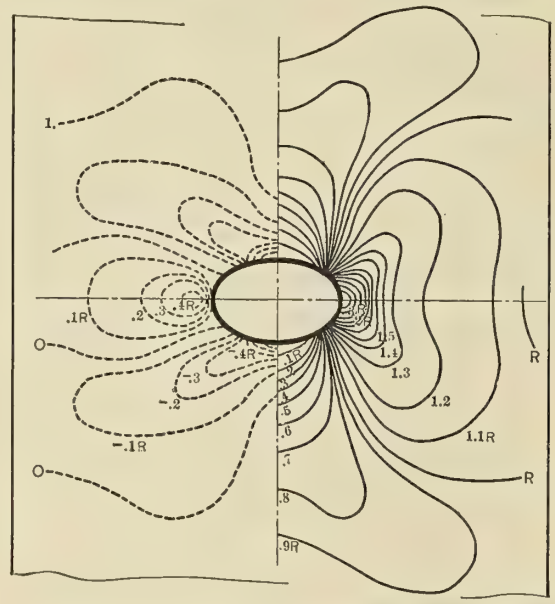


Fig. 9.—Contour Curves of Equal Values of P and Q

results, and, in fact, the values obtained confirm those described above, so that it is hardly worth referring to them in detail, except to point out that all the experiments for this type of hole agree in showing that the maximum stress is always approximately $(1 + 2\frac{a}{b})$ times the stress corresponding to that of the infinitely wide plate, where a and b are the appropriate values of the axes, and the hole is small.

The case of the elliptical hole inclined to the line of pull presents some interesting features not shown by the former cases. In the first place the maximum stress is not at the ends of either major axis, but is found at or near the point where the tangent line parallel to the line of pull touches the ellipse. The lines of stress, as may be surmised, only possess a bi-lateral symmetry, as is shown by the experimental determination, Fig 7, in which one also observes the tendency of the outer lines to bend outwards at some distance above and below the hole, and not in quite

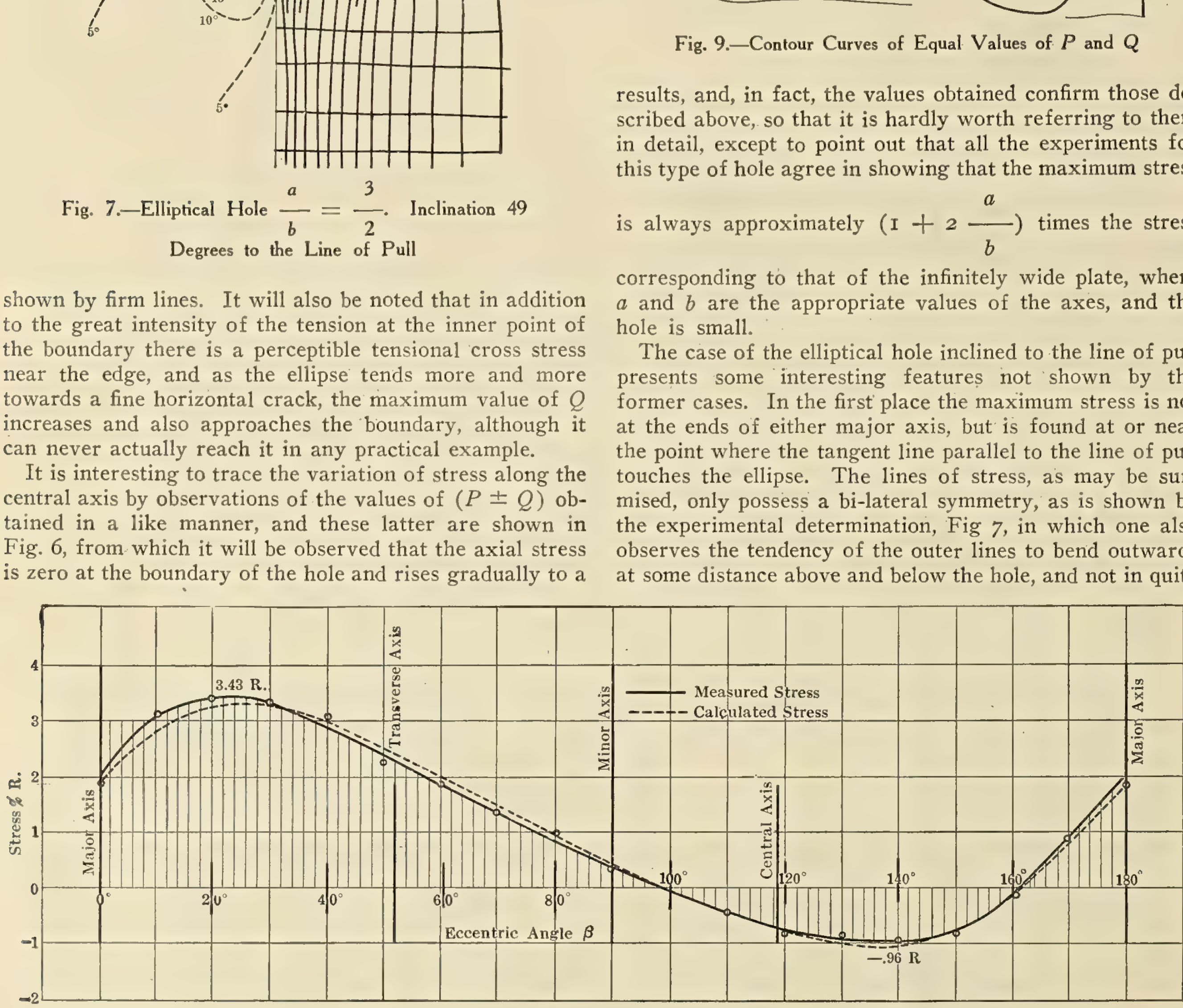


Fig. 8.—Stress at Edge of Inclined Hole

the same way above and below the transverse central plane. They appear, in fact, to indicate maximum stresses at the outer straight sides at unequal distances from the central cross-section, and polariscope observation confirms this.

The stress distribution round the hole has been deter-

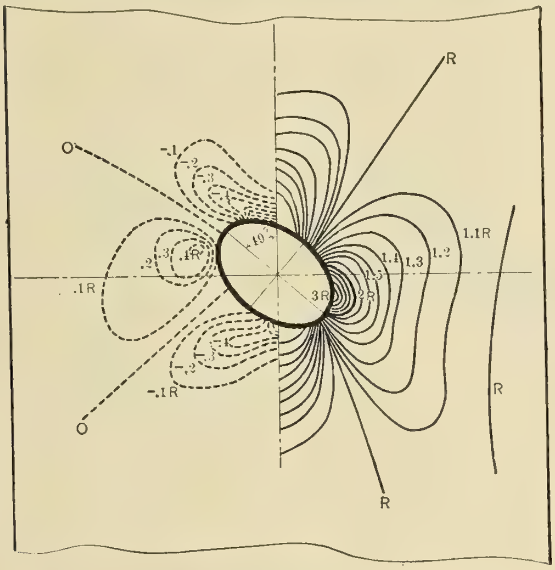


Fig. 10.—Contour Curves of Equal Values of P and Q

mined and compared with the theoretical expression of Inglis, and a very fair agreement is found, as Fig. 9 shows, in which the two are compared by plotting the stresses observed and calculated on a base derived from the eccentric angle β. The stress is found to vary between 3.43 R and —0.96 R, and is in good agreement with the theoretical expressions. It is also of interest to note that when the stress distribution is examined across the plane perpendicular to the line of pull and passing through the center of the ellipse, it is found to account for the total pull within one percent.

In the case of two of the ellipses studied, the stresses are determined at points along radial lines 22½ degrees apart, including the longitudinal and transverse sections. The values of P and Q are plotted and contour curves drawn, as shown in Figs. 9 and 10. The full line contours correspond to P magnitudes, and the dotted curves, shown on the left, to those of Q. For the transverse hole five sections are studied, to include one quadrant, and for the inclined ellipse eight sections, covering half of the area, are determined, in order to give the complete stress distribution. For the transverse hole there is quadrantal symmetry, and for the inclined one the symmetry is seen to be bi-lateral, corresponding in each case to the symmetries of the principal stress direction lines shown in Figs. 3 and 7. A noticeable feature shown by the P and Q contour curves is the great rapidity with which extreme values of stress fall off on leaving the edge of the hole. At a distance equal to twice the length of the major axis in any direction from the edge of the hole the values of P and Q have become substantially equal to those which exist at points remote from the hole. It is also to be noticed that where the stress at the edge of the hole is tension, the Q component vanishes, and where it is compression the P component vanishes, the transition points being the four points of zero stress. These points are indicated on Figs. 9 and 10.

Cracks

The experiments described above have also an especial interest, since the effect of a fine crack can be estimated from these results. If we consider it as the limiting case of an ellipse, in which the minor axis ultimately vanishes, an infinite stress is produced at the extreme ends for any inclination which does not approach too nearly to the direction of the pull.

Practical men have long been aware of the extreme concentration of stress produced by such cracks, and have provided a well-known remedy for stopping their extension, which is universally used, whether it be for a crack in a steel forging or in a delicate piece of china. It occurred to the authors, however, that the method of drilling circular holes at the ends of a crack might possibly be improved upon. If circular holes of small size are drilled at the ends, the effect is to reduce the stress concentration from some unknown but very large amount to approximately three times the equivalent uniform stress in the uniform plate. From the preceding results it seems probable that there might be a further reduction of stress, if elliptical holes or approximations thereto are drilled at the ends of a crack, with their axes so arranged that the position of maximum stress occurs at the end of the minor axis. In order to test this view, a tension member was prepared 1.56 inches wide, in which four fine slits were produced transversely to the line of pull and symmetrically disposed with reference to the axial line. The forms of these slits are shown in Fig. 11, but they were actually spaced very much further apart in order to obtain uniform stress conditions in the intervals between them, and the contours of the holes were much larger than necessary for practical requirements in order to permit of a more accurate study of the stress effects produced.

The ends of the first slit A were left exactly of the form produced by a drill of 1/32 inch diameter, which happened to be available; the ends of the second B were finished with holes of ⅛ inch diameter; the third C with vertical slots of ¼ inch length, made by drilling ⅛-inch holes tangential to the centerline of the slit and afterwards removing the angles left by the drill. The fourth D was produced in a similar fashion, and the outer part curved to a radius of 0.22 inch to give an approximately elliptical contour.

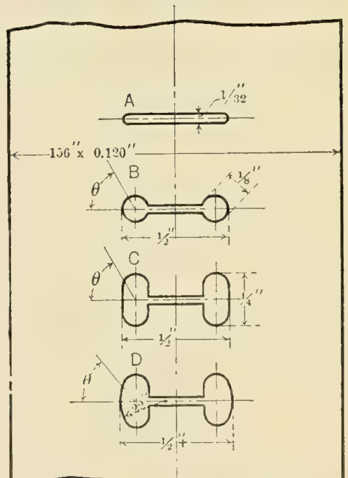


Fig. 11

The total width of the slit was ½ inch in all cases, except for D, and an allowance for the extra stress produced by the increase in the size of the latter is, therefore, made for comparison purposes. The specimen so prepared was then subjected to a load of 100 pounds (corresponding to a mean average stress of 790 pounds per square inch) in a small testing machine and the stresses round the contours determined for a sufficient number of points to make a comparison effective. The values so obtained are shown in Fig. 12, in which all are compared by aid of angles θ as abscissæ and stress as ordinates, so far as this is possible, and the remaining parts of the contours of C and D by linear measurements along the contour. The distances in the two latter cases are not quite the same, but the difference is not material. The comparison at once shows that for the simple case taken it is possible to materially reduce the high stress caused by a semicircular ending to a crack by drilling out a nearly complete circle, and proves the value of the practical means usually adopted, especially for a hair-line crack, where presumably the stress effect is very great. The substitution of form *C* effects a still further improvement by lowering the stress intensity from 2,250 to approximately 1,670 pounds per square inch, with a minimum value at an angle of $\theta = 15$ degrees approximately, and a minimum value at the central section of about 1,250 pounds per square inch. The form *D*, as might be expected, gave a maximum stress at the central line, and, as measured, corresponded to a stress of 1,700 pounds per square inch when the extra width was taken into account. Practically there seems little to choose between these two last forms, although the experiment is not decisive one way or the other. Having regard to the measurements on elliptical holes it is possible that form *D* is actually the best one to adopt if the proper shape of elliptical hole is chosen.

Stresses Around Hatchway Openings

It is unnecessary here to refer particularly to the case of a large circular hole in a tension member of finite width, as these have been examined in an earlier paper, but there are many other types of discontinuity which are of importance, and an interesting practical case to which shipbuilders have devoted considerable attention is that of hatchways in ships' decks. They are probably subjected to complicated load systems not easy to define or to produce in the laboratory, but a simple type of loading, such as that of a pull, serves at any rate to bring out some characteristic features. The chief places of interest in all such cases of sudden discontinuity appear, in general, to be at or near the sudden change of section, and the case selected shows this quite well, although it would probably be easy to obtain a more characteristic one.

This example consists simply of a square hole of 2-inch sides cut in a plate of 5-inch width and having rounded corners of half an inch radius, the sides being parallel and perpendicular to the pull.

The large radii at the angles were chosen with the object of getting precise measurements at points of this part of the contour, and are greater than is usual in practice. The maximum stress occurs at the interior contour and

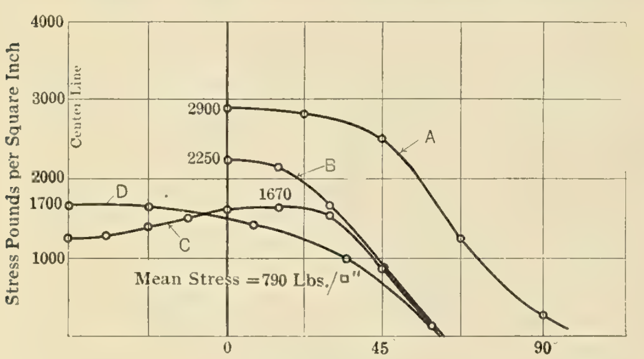


Fig. 12

near the joint of the rounded corners, with the sides parallel to the line of pull. There are also indications of a subsidiary maximum along the external contours at a considerable distance from the hole. These observations are amply confirmed by the measurements shown on Fig. 13, in which the stress distributions around both contours are shown for a total load of 390 pounds, giving a mean stress of 840 pounds per square inch at the reduced central section. In addition, the stress distribution across this latter section is shown by aid of observations of $(P \pm Q)$ shown in dotted lines, from which it may be observed that the cross-stress *Q* is negligibly small, while the maximum value of *P* at the interior contour along this section is 1,290 pounds per square inch.

Integrating the curve there shown and comparing it with the pull applied, it is found that the mean error of observation is approximately 3 percent, which is a useful test as giving an idea of the general degree of accuracy

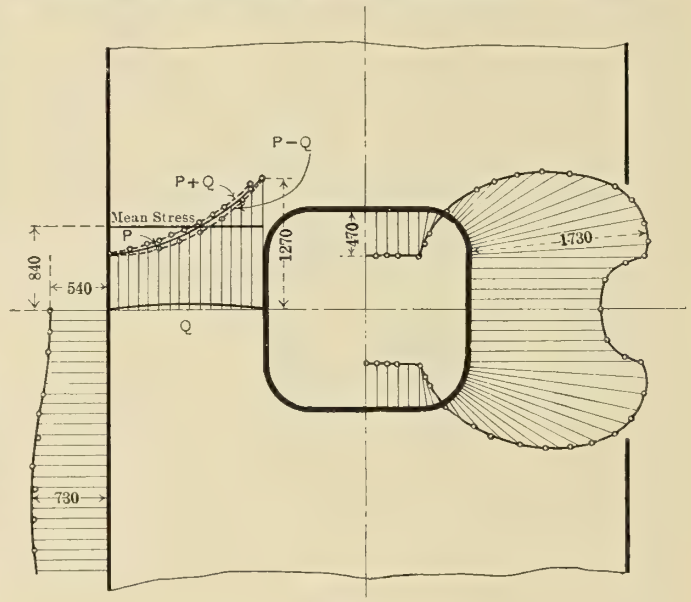


Fig. 13

obtained. The actual maximum is at the commencement of the angle and just beyond the joint of the straight and curved portions, with a value of 1,730 pounds per square inch, or 2.06 times the value of the mean stress at the central cross-section. It is also easy to show that as this curve lessens in radius the stress increases and becomes dangerously great, even with a moderate load.

As we pass still farther along the curve, the stress rapidly diminishes and finally changes sign and becomes a compression of fairly uniform value along the plane contours. The outer contours also show the characteristic feature, already mentioned above, for another case of a minimum value at the central section with maxima on either side, but in this case these latter values are not very pronounced owing to the distance of the hole from the outer boundaries.

It is probable that a study of other cases of hatchway openings of more immediate practical importance than the one described here would afford information of value in practical construction.

Correction.—On page 825 of the October issue of Marine Engineering there was published a photograph of a United States destroyer over a caption which describes the vessel as the U. S. S. *Satterlee*, giving the official figures for the speed and power of this vessel during her official trial. Inadvertently, however, the photograph reproduced on this page showed the United States destroyer *Cole* instead of the *Satterlee* described in the caption. The destroyer *Cole* was built by William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. The propelling machinery of the *Cole* consists of twin sets of Parsons single reduction geared turbines supplied by the Parsons Marine Steam Turbine Company, Ltd., the reduction gears for which were supplied by the De Laval Steam Turbine Company, Trenton, N. J. According to unofficial figures supplied by the builders, the destroyer *Cole* during a straightaway top speed run maintained a speed of 41.1 knots.

Fuel for Diesel Engines

BY C. H. PEABODY, DR. ENG.

For the development of a permanent American merchant marine the Diesel engine is most important if not absolutely necessary, especially for the most numerous class of ships, namely the moderate sized freighter. The adaptation to that service is now complete, and the engine has the advantage of fuel economy and of requiring a small engine room crew; more especially, it does not call for firemen. The supply of oil available for Diesel fuel is not unlimited, however, so a review of the various sources will serve to point out what may be expected in meeting fuel requirements as oil engines are further developed.

It is interesting to consider what fuels are available for the Diesel engine, and what are their properties. The hot-bulb engine, sometimes called the semi-Diesel engine, has such resemblance to the Diesel that its requirements can be considered at the same time.

The usual fuels for these engines are:

Petroleum products; heavy distillates, gas oils and residues, and sometimes the crude oil itself.

Shale oils, either crude or heavy distillates.

Coal tars, either raw or heavy distillates, or in some cases crude naphthalene.

Petroleum comes first on the list and is first in importance at this time. Though everybody is familiar with the light distillates sold all over the country as gasoline, and with certain other products like kerosene and naphthalene, few know the raw oil which has a vile color and a viler smell. The composition of the oil is hidden by the chemists under such names as pentatriacontane, but a fair working idea of the essentials is not so hard, nor is it hard to grasp the differences of the various petroleums and other oils and of tars used in Diesel engines.

Characteristics of Various Oils

In this country we have the Pennsylvania oils which are thin with a paraffin base, and the Texan and Mexican oils which are thick with an asphalt base. The South American oils are like the Texan, and the East Indian are more like the Pennsylvanian, while the Russian oils are intermediate in quality, though having a notable chemical difference. Our ships, especially the ubiquitous tramp, are liable to become acquainted with all of them.

All the oils and tars that we are considering consist essentially of hydrocarbons—that is, of various combinations of hydrogen and carbon in all sorts of proportions; other matters, like sulphur, nitrogen and oxygen, occur in small quantities and may be treated as impurities. Sulphur, when in considerable quantity—say 3 to 5 percent—is sometimes troublesome, but it is said that it does not give trouble when the fuel is burned in a Diesel engine. Should there, however, be an appreciable amount of ash, or should free carbon be deposited, the trouble is liable to begin. This seems a little remarkable considering that Dr. Diesel expected to burn powdered coal in his engine and thought that the ash would not be important.

The Pennsylvania oil is said to have a paraffin base; more properly we should say that the oil consists of various members of the paraffin series. The chemists consider that this series begins with marsh gas or methane, which has one atom of carbon and four atoms of hydrogen. The series advances by adding successively one atom of carbon and two of hydrogen; for example, the fifth of the series is pentane and is written $C_5 H_{12}$. This is the principal constituent of righoline, which is the lightest petroleum distillate sold on the market, and which is used as a local anesthetic. Since it boils at 64 degrees F., it may be said to be a liquid in winter and a gas in summer. Natural gas begins with methane and goes down to pentane or even lower.

Gasoline is supposed to take on the distillates from 160 degrees F. to 300 degrees F., and kerosene goes from 300 degrees F. to 600 degrees F. Heavier distillates are used for lubricants, for enriching illuminating gas and as fuel for hot-bulb and Diesel engines. By the process of "cracking" the amount of lighter distillates can be much increased. Under the stress of demand for gasoline the range of temperature is forced at both ends and the heaviness due to encroaching on the kerosene distillates is counterbalanced by "livening up" with some of the series derived from natural gas.

The oils and waxes used as fuels for the Diesel engine are distilled within the range from 300 degrees to 600 degrees or more. Paraffin candles come about the middle of the range, and pentatriacontane is about the lower limit.

The various paraffins are known as saturated compounds and are stable and inert. The oils and waxes when pure are colorless and tasteless. From coal tar may be obtained the aromatic compounds benzene, toluene and naphthalene; they are unsaturated compounds and are less stable than the paraffins, which also burn more readily.

Naphthalene, which is a solid, can therefore be used to run the Diesel engine, if melted so that it can be atomized by an air blast. Trinitrotoluene, or T.N.T., is made from toluene, which is a liquid boiling at 230 degrees F.

The Russian oils are largely made up of a series of even more complex compounds which are chemically related to the aromatic compounds, but the fuel user will find that they appear to resemble the paraffin of the Pennsylvania oils. They have the property of being unsaturated and burn more easily than the paraffin, i. e., thicker oils can be worked in the Diesel engine. Having in mind the vile smell of raw petroleum, it is curious to find that certain products of the Russian oil are used in perfumery, but the vagaries of those using perfumes is beyond finding out, and we have in mind that civet was once so used.

Critical Temperatures of Oils

There are two very important temperatures for any fuel oil—first, the flash temperatures, and, second, the temperature of spontaneous ignition. The first has to do with safety, and the second with availability. Since crude oils are liable to contain all the compounds that are not gaseous at ordinary temperatures, and may hold some gases in solution, the flash temperature is likely to be low; that is, such oils are very dangerous. It is most strongly advised that such oils be avoided, and when circumstances force their use the greatest precautions must be observed; they are likely to be more dangerous than gasoline.

Now the Diesel engine commonly compresses air to 500 pounds, at which it has a temperature of 1,000 degrees F.

Then naphthalene, which has an ignition temperature of 750 degrees, gives no trouble. It appears that benzole, which requires more than 1,000 degrees, may be troublesome. Certain tar oils, to be discussed later, require a higher compression and temperature to ignite regularly, whereas the Diesel engine has already too heavy a compression for convenience. Petroleums and their products seldom give trouble in igniting unless heavy residues of asphaltic oil are used, but such fuels are objectionable on other accounts and should be avoided.

Combustion of Asphalt

A good deal has already been said about asphalt, and it may be interesting to remember that it is found in lakes and springs at the outcrop of petroliferous strata as at Trinidad, and is usually a viscous solid. A similar product may be obtained by blowing air through the hot residue left in petroleum stills. Asphalt, either natural or as found in petroleum or in tars, is soluble or partially soluble in the lighter petroleum distillates, but it cannot be distilled; on the contrary, it breaks up when heated, depositing free carbon. This is the essential reason why it gives trouble in Diesel engines.

The carbon deposited from an asphaltic oil gathers on the top of the pistons and it clogs the atomizing devices, and, worse yet, burning particles of carbon or coke attack the surfaces of the exhaust valves and the valve seats. At one time this action was attributed to sulphur, which may attain a percentage of four or five, but it has been shown that soft asphalt through having such a high percentage of sulphur can be used in Diesel engines. On no account should engines be allowed to smoke at the exhaust because they will become badly carbonized in a short time.

The crude asphaltic oils are likely to be accompanied by water and solid impurities which do not readily separate from the oils on account of their high specific gravity and viscosity.

The difficulty of viscosity may be overcome by heating the oil before it approaches the atomizer, but heavy asphaltic oils or residues may leave deposits in storage tanks and are sure to give trouble when pumped unless heated. Now it may not be difficult to supply heat to storage tanks on steamers, but a ship having Diesel engines is another matter; truly such a ship may have a donkey boiler or the jacket circulation may be available, but it will lack a good supply of hot steam.

Characteristics of the Hot-Bulb Engine

The hot-bulb engine resembles the Diesel engine in that air only is compressed in the cylinder and the fuel is sprayed in when the compression is complete. The difference is that the compression is not sufficient to produce ignition and there is a hot-bulb or hot plate against which the fuel is sprayed and ignited. The bulb, plate or other device retains enough heat to produce the ignition; when the engine is started, the bulb or plate must be heated by a torch or otherwise. Hot-bulb engines require lighter and more expensive oils than Diesel type engines; they have not as yet been made in so large sizes.

Possibilities of Recovering Oil from Shale

The shales of the British Isles have long been worked for oil and produce an appreciable quantity—about 6 percent of the world's production of petroleum. In America there are mountains of shale, much of which can be worked in open quarries, whereas the British shales are mined like coal. When attention is attracted by new oil fields, especially if they are large gushers, the possibilities even of ranges of mountains of shale leaves one as cold as the mountains themselves. But it is a truism that any business has to carry all its failures. It is necessary to pay for all the dry wells, and even the waste of speculation must be borne by the industry. In mining, a low grade ore easily won and worked is better than scattered pockets, however rich. It is likely that well-financed plants for working shale will deliver a large part of the mineral oil of the country in the near future.

Shale which is a slaty mineral impregnated with petroleum carries only 20 to 25 percent of oil. Since the cost of fuel is mainly that of transportation, no one can afford to burn it except at the beds. It is mined, broken up and distilled in retorts which can be heated by the retorted rock; it is not necessary to use good fuel. The distillates are mostly light hydrocarbons similar to those from petroleum, but there are other valuable products such as ammoniacal liquor. It may even be a question which is the main product and which is the by-product now that nitrogenous fertilizers are so sought after.

The crude shale oil contains so large a portion of light compounds that it is undesirable for Diesel engines; with the present and prospective demand for gasoline, there is no likelihood of any getting on the market. The heavier products are well adapted to both Diesel engines and hot-bulb engines; there is no trouble from asphalts.

Other Sources of Fuel Supply

A very important source of fuel for Diesel and hot-bulb engines is coal tar, large quantities of which are produced every year. There are four kinds of such tar, gas house tar, coke oven tar, black furnace tar and lignite tar. The qualities of the various tars depend on the fuels used and also on the method of production.

Lignite is so inferior as fuel that it may be retorted to make tar, the residue being used as fuel for the retorts. The tar may be burned raw in Diesel, but not in hot-bulb, engines. The distillates contain both paraffin and aromatic compounds, and it is likely that ammonia will prove a valuable by-product. Since the lignite coke has little value, the distillation can be controlled to give the best yield of products. The lighter products are, of course, used as gasoline; the heavier products resemble those from petroleum and can be burned in Diesel and hot-bulb engines.

Gas for illuminating and heating is made by two processes—the old retort process and the so-called water-gas process, by which the carbon in the coal is burned to carbon monoxide. Both processes yield tar and other products, notably ammoniacal liquor. A certain Scottish shipyard uses gas for power and heating; before the war the ammoniacal yield per ton of coal was worth three shillings, the coal cost six shillings—an unexpected combination of agricultural and maritime interests. Tars by this process are not available for engines when raw on account of the high proportion of water and ash.

The old-fashioned horizontal gas retort makes a heavy tar that cannot be used raw in Diesel engines. The newest type of vertical retort as developed in Germany, but now used everywhere, makes a thinner tar that may be used raw. In general, engines must be specially designed to burn crude tar and usually have a higher compression because that material has a high spontaneous temperature of ignition.

The following method of overcoming this difficulty of ignition was proposed in 1916 by Mr. C. Day, and may be in use now. Two fuel pumps are used, one for the crude tar and another for a lighter petroleum or shale oil product, which ignites readily. Since only a small portion of lighter oil is used, it need not be under the control of the governor.

Diesel estimated that there was tar enough in Germany to provide power for all industrial purposes and for the navy.

Tar Available as Fuel

It is unlikely, however, that coal tar will be squandered in any such way, because they contain large portions of aromatic compounds from which dyes and explosives are made. The heavier products are well adapted for Diesel engines. Naphthalene, which is a solid, has been used to a considerable extent in Germany when it was cheap enough. Since the use of tar oil began in Germany and was most extensive there, it may be interesting to read the specifications of the German Tar Distillers' Federation:

1. The tar oil must not contain more than 0.2 percent of solids.
2. Water must not exceed 1 percent.
3. Coking residue must not exceed 3 percent.
4. By distillation, at least 60 percent; by volume, must be over 570 degrees F.
5. The calorific value must not be less than 35,000 British thermal units.
6. The flash point must not be lower than 150 degrees F.
7. The oil must be quite liquid at 60 degrees F. When cooled to 47 degrees F. no precipitation must take place after resting half an hour.

The tars from coke ovens resemble those from vertical gas retorts, and some of them may be used for Diesel engines. Mr. H. Moore reported in 1916 that he had run a Diesel engine six months on raw tar from a certain type of coke oven.

Tar collected from blast furnaces contains too much ash to be used in engines; on distillation it yields a small amount of light products and a large amount of paraffin products.

This completes our survey of the field of the present day, for, though peat may yield distillates, there is no present prospect of such use of that fuel, and though vegetable and animal oils readily burn in Diesel engines, they are worth too much for other purposes.

Whatever oil is used in internal combustion engines, it should be bought and sold on specifications and should be tested by experts. Though directions for testing may be published, and though they may appear simple enough to an engineer, he will be ill advised to spend his time on them and cannot be confident of his results. The suggestion might be made that companies dealing in fuel oil will find it good business to submit their fuels on specification and to guarantee them on reports from their experts. The reputations of the companies and their experts will be a sufficient backing, and only large consumers will find it worth while to employ experts on their own account. Though engineers should not undertake any tests of oils however simple, they are entirely competent to understand and use the reports of experts.

Diesel Engine Experimental Work*

BY ENGINEER-COMMANDER C. J. HAWKES, R. N. (RET.)

The object of this paper is to place before the members of the Institution an outline of the experimental work carried out at the Admiralty Engineering Laboratory in connection with internal combustion engines for naval purposes, with special reference to the design and performance of a single-cylinder engine of comparatively large power.

In 1916, as the result of the representations of the Board of Invention and Research, it was decided to establish an engineering laboratory on a small scale, the work, at first, to be confined to experiments with internal combustion engines. The question of the material and design of pistons of submarine oil engines was referred to the Board of Invention by the Engineer-in-Chief of the Navy and the matter was first considered at a meeting of the Internal Combustion Engines Sub-Committee on November 29, 1915. It was decided to construct a single cylinder oil engine for experimental purposes, utilizing, so far as possible, the parts of a standard submarine engine, in order to save time and also to keep down the cost. The drawings of the piston, connecting rod, bedplate and other parts not of the standard design were made at the Board of Invention and the engine was constructed and erected at the works of Messrs. Ruston & Hornsby, Lincoln. The engine was first run without load on July 17, 1916.

Material and Design of Pistons of Submarine Oil Engines

Several designs of pistons were considered by the Sub-Committee, including pistons of aluminum alloy in two pieces and also pistons having aluminum alloy heads and suitably lightened bronze or cast iron skirts. Eventually it was decided to commence the experiments with a piston of aluminum alloy, and, in order to keep down the weight of the piston, a comparatively low copper content was decided upon. It was uncertain whether this piston would stand up to its work for any length of time, especially having in view the composition of the aluminum alloy then being recommended for pistons of aircraft engines, but it is interesting to note that the original piston is still in use and it has been run for a considerable time at comparatively high speeds and high mean pressures.

The trunk piston was divided at the gudgeon pin center and the two top-end bearings were carried between its upper and lower portions—the gudgeon pin, to facilitate dismantling, being at first made a driving fit into the eye of the connecting rod. This design followed a suggestion which was put forward some years before in connection with ordinary cast iron pistons, with the object of obtaining a slightly greater gudgeon pin bearing surface. The top-end brasses, which were lined with white metal, were not adjustable. Lubrication was effected by forced feed from the crank shaft through the center of the connecting rod and thence through channels in the hollow gudgeon pin to the bearings. The bearings were held in position by steel end plates. Six cast iron piston rings were fitted in addition to a scraper ring, but, with the object of reducing the possible wear of the piston grooves, the widths of the working faces of the rings were made ¼ inch, as compared with ⅜ inch in the standard cast iron pistons.

The connecting rod was made of 30 to 35 tons steel and was of I-section, the connecting rods of standard submarine engines being of round section. The diameter of the cylinder of this engine (which, for convenience, is known as the "Unit" engine) is 14½ inches, stroke 15 inches, and of 100 nominal brake horsepower at 380 revolutions per minute. Solid injection was first used, but later air injection was fitted for experiments with a modified type of air injection valve.

After the engine had been running at the full nominal

* From a paper read at the summer meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

load for some considerable time it was opened up for examination. It was found that the gudgeon pin was slightly slack in the connecting rod, and it was decided, therefore, to modify the skirt portion of the piston so that it would pass over the foot of the rod for dismantling and thus permit a "shrunk in" gudgeon pin to be fitted.

When these modifications had been carried out the engine was transferred from Lincoln to the Admiralty Engineering Laboratory and the trials were continued in September, 1917. The engine was run at or above 100 brake horsepower at revolutions from 380 to 500 per minute and at mean pressures from 100 to 140 pounds per square inch, and it was not opened out for examination again until July, 1918. It was then found that the piston was in good condition, but the white metal of the gudgeon brasses had worn slightly. It appeared evident that this wear was largely due to the fact that the oil grooves had not been cut in accordance with the instructions on the drawing, and this resulted in reducing the supply of lubricant to the grooves. It was also found that the brasses had hammered very slightly into the aluminum body of the piston and there was evidence that the side clearances between the connecting rod and the brasses were insufficient.

It was decided to bore the eyes of the piston larger, make new brasses of correspondingly greater thickness, with flanges at each end, and to fit more substantial keys to prevent the brasses turning in the piston, as the small keys originally fitted were found to be slack. The experiments have been continued since August, 1918, at mean indicated pressures up to 140 pounds per square inch, but it has not been necessary to make any further modifications to the piston. Whenever the piston has been dismantled it has been found in good condition, and careful gaging has shown that there is no appreciable wear either in the body of the piston or in the grooves, and so far there is no indication of "growth." The cast iron cylinder liner is in excellent condition.

The weights of the aluminum alloy piston and I-section connecting rod of the experimental engine are appreciably less than the weights of the corresponding parts of the standard submarine engine, with the result that the inertia forces in the former at 500 revolutions per minute are approximately the same as in the latter when running at 380 revolutions per minute. The comparative weights of the reciprocating and rotating parts of the experimental cylinder and the standard engines are shown in Table I.

TABLE I.—COMPARISON OF WEIGHTS OF PISTONS AND CONNECTING RODS IN EXPERIMENTAL AND STANDARD SUBMARINE ENGINES

	Experimental Engine	Standard Submarine Engine
Cylinder diameter, inches	14½	14½
Length of stroke	15	15
Revolutions per minute	380	380
Weight of piston, with rings, bushes (in the case of experimental engine), guards, etc., pounds	213	390
Weight of connecting rod, with gudgeon pin and large end bearing and bushes (in the case of standard engine), pounds	290	423
Reciprocating weights (includes two-thirds weight of connecting rod without palm end), pounds	310	560
Rotating weights (includes palm end and one-third weight of connecting rod), pounds	193	253

With the particulars given in Table I the mean pressures on the various bearings throughout the cycle, at 380 revolutions per minute, were obtained for each engine and the results are shown in Table II.

TABLE II.—MEAN TOTAL BEARING PRESSURES THROUGHOUT CYCLE IN POUNDS

Engine	Gudgeon Pin	Crank Pin	Cylinder Liner	Main Bearings
Experimental engine	12,320	16,200	1,420	16,200
Standard engine	15,250	20,260	1,840	20,260

It will be seen, as would be expected, that there is a considerable reduction in the mean total loadings of the bearings due to the use of the aluminum alloy piston and lighter connecting rod, and as the mean rubbing velocities of the various bearings are the same for both engines at 380 revolutions per minute, this reduction is a measure of the increase in the mechanical efficiency of the experimental engine as compared with the mechanical efficiency of the standard engine. This increase in mechanical efficiency would appear to be of the order of 2 percent.

Clearances Between Aluminum Alloy Piston and Liner

The coefficient of linear expansion and the thermal conductivity are greater for aluminum than for cast iron, and in the absence of information so far as large engines were concerned, it was difficult in the design stage to decide on the clearances which should be provided between the aluminum alloy piston and the liner. Eventually it was decided to make the clearances similar to those usual with cast iron in Diesel engines and to note the results. When the engine was first started, and after the engine had been running at a small load for some time, the piston seized. The piston was removed and examined and it was found that it had been in contact with the liner over nearly the whole of its surface and the metal was scored slightly. The piston was therefore "draw filed" and replaced and the engine again put on load. At the higher loads there was a slight seizure and again the body of the piston was filed where it had been bearing hard on the liner. Since that time, although the engine has been running at high speeds, etc., no further seizures have taken place. From the experience gained it may be taken that the clearances required with an aluminum alloy piston should be about 50 percent greater than the clearances necessary with a cast iron piston. Should a cast iron piston seize, it generally results in damaging the liner as well as the piston, but in the case of the aluminum alloy piston it was found that a seizure did not damage the surface of the liner in any way. Further, it was found that as soon as the engine had cooled down slightly after a seizure the aluminum piston was quite free.

There is no doubt, so far as present experience is concerned, that aluminum alloy pistons, although slightly greater in first cost, have many advantages over cast iron pistons. Further experience will shortly be available as to their behavior under actual service conditions, and it will then be possible to decide whether their extended use for submarines is justified. In the meantime other Admiralty experimental engines, including the two-stroke cycle type, have been or are to be fitted with pistons of aluminum alloy for further test.

Capacity of Piston to Withstand Higher Mean Pressures

In view of the results obtained with the "Unit" engine it was decided, when the engine had been transferred from Lincoln to the Admiralty Engineering Laboratory, further to test the capacity of the piston to withstand higher mean pressures by supercharging and also to run at higher speeds. The two methods of supercharging considered were (1) to compress to the supercharging pressures the whole of the air required by the engine by means of a blower or pump, the air passing through the induction valve, or (2) to allow the engine to draw air from the atmosphere through the induction valve in the ordinary way and to add at or about the commencement of compression the additional air for supercharging through ports uncovered by the piston or through an additional valve in or near the cylinder head.

The alternatives were fully considered, but as the principal object at that time was to test the aluminum alloy piston, it was decided to adopt (1), as it did not involve any structural alterations to the engine. It was consequently arranged to compress to the supercharging pressure the whole of the air required by the engine by means of a standard Roots blower, driven by belt from an electric motor. The blower delivered air under pressure to a reservoir, which was fitted with a combined relief and pressure regulating valve, so that the supercharging air could be adjusted to any pre-determined pressure within the capacity of the blower. A three-way cock was fitted

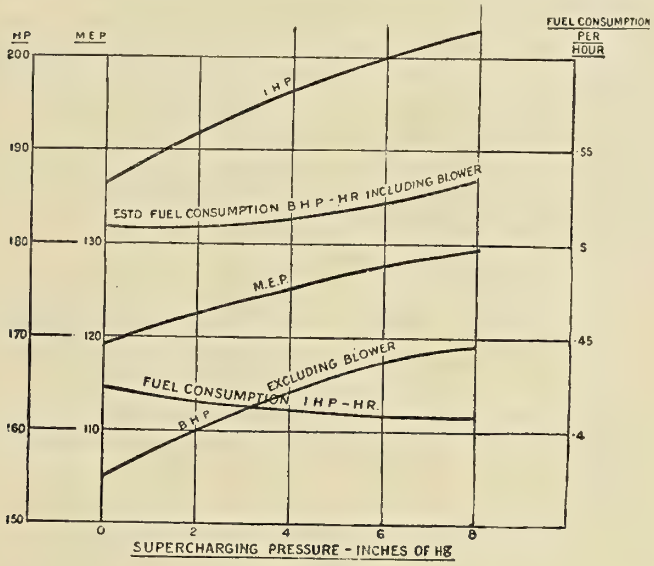


Fig. 1

in the induction pipe so that the engine could take its supply of air either from the atmosphere or from the reservoir. This arrangement gave no trouble, but it was found that the temperature of the air delivered at 3 or 4 pounds pressure after a time rose appreciably and a water jacket was therefore fitted to the blower.

Tests were then carried out with and without supercharging at various speeds up to 500 revolutions per minute, using the maximum quantity of fuel oil delivered by the fuel pump. A six-hole sprayer was necessary at the higher speeds and the pressure in the solid injection system was maintained, as nearly as possible, at 4,000 pounds per square inch by adjusting the fuel valve roller clearance, thus varying both the lift and period of opening of the fuel valve. Further, the compression pressure was 380 pounds per square inch and the average initial, or maximum, pressure was kept at about 630 pounds per square inch by adjusting the timing gear as necessary for each test. The same brand of fuel oil was used throughout, viz., heavy shale oil of specific gravity 0.86 at 60 degrees F. The quantity and rise in temperature of the cooling water to the jacket, cylinder cover and exhaust valve were measured.

During the tests the blower was run at its lowest speed, but the amount of air delivered was in excess of that required at all engine speeds. A calculation had to be made, therefore, based on the curves of output and power furnished by the makers of the blower, in order to obtain the power required to supply the air actually used in the engine. The blower was not very efficient and the calculated power required to supply the supercharging air were known to be in excess of those which would be necessary in practice. The results obtained during the 500 revolutions per minute series of tests which were run with supercharging pressures corresponding to 0, 2, 4, 6 and 8 inches of mercury (as measured by a mercury gage in communication with the reservoir) are shown graphically in Fig. 1. The fuel consumptions per brake horsepower hour inclusive of the blower are estimated. Each trial was of 1½ hours' duration.

Although the powers developed during the tests were limited by the capacity of the fuel pump, the results obtained could not be regarded as satisfactory. The exhaust was not clear during any test and it was evident that it was necessary either to make some alteration to the fuel sprayer or to adopt a different system of fuel injection.

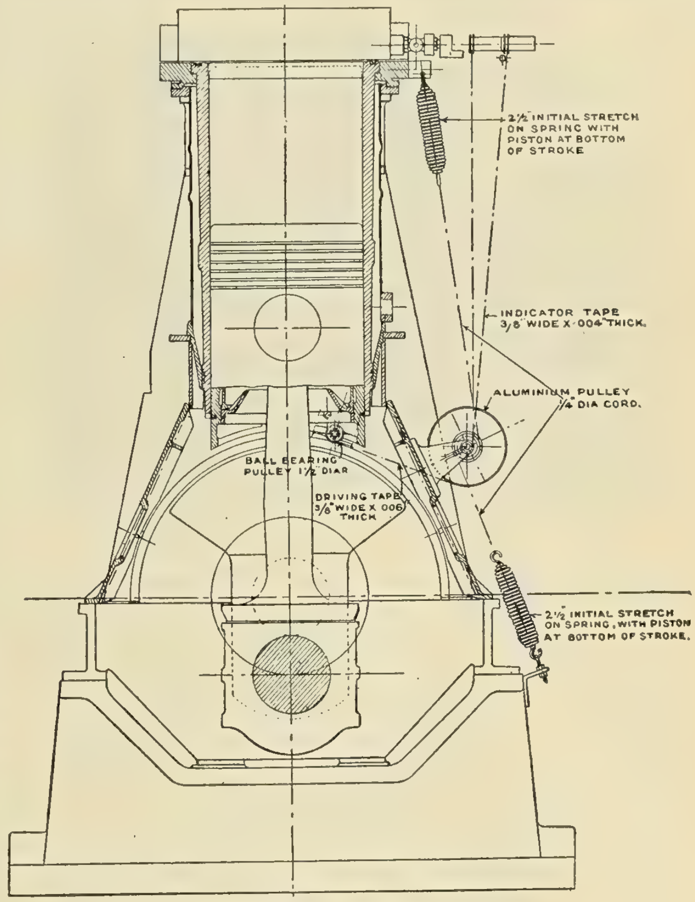


Fig. 2.—Arrangement of Indicator Gear

It was therefore decided that no good purpose would be served by continuing these tests, and it was consequently arranged to experiment with the fuel injection system and to defer the supercharging tests until a later date.

Better results, both as regards power and fuel consumption, would have been obtained by running these tests at higher initial pressures, but it was desirable, at least for the present, to limit the maximum pressure to that usually worked to on service. The results could also have been improved by using a higher fuel pressure in the solid injection system, but, again, it was considered advisable at that stage, and with the fittings then in use, to limit the pressure to 4,000 pounds per square inch. During the later tests diagrams were taken from the fuel system with the object of ascertaining the variation of pressure during the cycle. It was found that with a gage pressure of 4,000 pounds per square inch in the fuel system, with the engine running at 420 revolutions per minute, the maximum pressure was 4,560 pounds and the minimum pressure 3,400 pounds per square inch.

The exhaust pipe outlet to the atmosphere is some considerable distance from the engine, and for convenience it has been arranged to spray water into the first of the two silencers fitted and to note the color of the discharge from the silencer drain by passing it over a plate of glass painted white on its under side. It has been found that this method is very sensitive and can always be relied upon to give a true indication of the color of the exhaust. This method has also been used successfully for other experimental engines.

The indicator rig originally fitted to this engine was considered to be unsatisfactory and a new gear was fitted, an arrangement of which is shown in Fig. 2. It will be seen that a steel tape 0.006 inch in thickness has one end connected to the piston and the other end connected to the

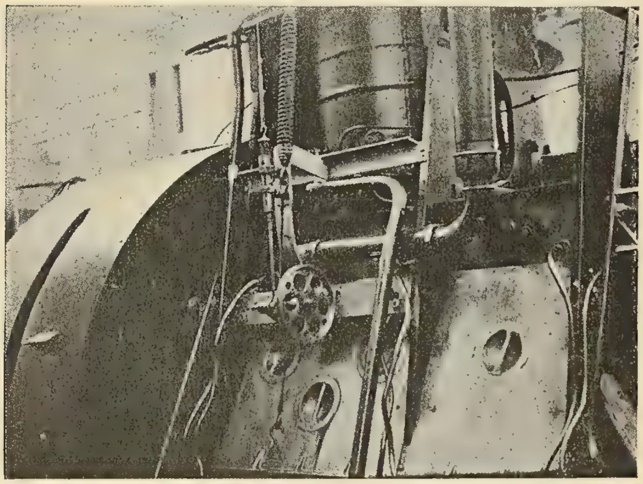


Fig. 3.—Indicator Gear Attached to "Unit" Engine

rim of an aluminum wheel, which is mounted on a small shaft carried in a bracket attached to the engine framing. This tape passes over a ball-bearing pulley 1½ inches diameter. The shaft carrying the aluminum wheel also carries the pulleys to which the tension springs are connected and the pulley from which the indicator tape is taken. By this means a true copy of the movement of the piston can be obtained.

Some difficulties were experienced in connection with the tension springs and the tape fastenings, but by running the whole of the gear in the open by an electric motor, so that all parts were under observation, these difficulties were readily overcome. Various minor alterations were made later, but the principle of the gear has remained the same. A photograph of the gear attached to the "Unit" engine is shown in Fig. 3. Since that time a large number of strands of rubber have been successfully used in place of the tension springs.

Obturator Ring

It may be interesting to mention, in connection with the "Unit" engine, that an obturator ring has been fitted to the piston since August, 1918, and has given fairly satisfactory results. The use of the obturator ring for Diesel engines was brought to notice by Messrs. The Engineering and Arc Lamps, Ltd., of St. Albans, as a number of experiments had already been carried out in an engine at the St. Albans Electric Power Station and very promising results obtained. In the St. Albans engine the first three cast iron piston rings were "pegged in" for the purpose of filling the grooves, an obturator ring of L-section, and about 1.5 millimeters in thickness, was fitted in the fourth groove, and the three remaining worn rings below the obturator ring were retained unaltered. An appreciable clearance was provided between the edge of the obturator ring and the groove in which it was fitted.

The question of the gas pressure behind the obturator ring during the cycle was discussed with the firm's representatives and it was suggested to them that it would perhaps be an advantage to fit a cast iron ring in the top groove of the piston in order to protect the obturator ring from the hot gases. Later, when it was decided to fit an obturator ring to the "Unit" engine for experiment, provision was made for a cast iron protection ring designed to give a radial pressure of about 1 pound per square inch. Further, the clearance between the edge of the obturator ring and its groove was reduced to 0.002 inch, as by this means it was considered that the pressure behind the ring would, by wire-drawing, be reduced to a minimum.

The arrangement of the L-sectioned obturator ring in the "Unit" piston is shown in Fig. 4. The material used is phosphor bronze and the thickness of the ring is 0.05 inch. A lap joint, riveted and silver soldered to one end of the ring, is provided to ensure gas tightness past the gap. A filling ring is fitted, made in halves spigoted together, its width being such that it just allows freedom of movement of the obturator ring.

When the obturator ring was fitted to the "Unit" engine the compression ratio was increased, as it was uncertain whether the ring would be gas-tight when starting up. Later, however, the compression was reduced again to 380 pounds per square inch at 380 revolutions per minute. When the engine was first run with the obturator ring, especially for about 15 minutes after starting, an appreciable quantity of gas passed the piston into the crank case, which would be an objectionable feature so far as its use for submarine engines is concerned, so the ring was removed and eased slightly to give it more freedom. It was clear that only portions of the ring were in contact with the liner and its surface was therefore smoothed up as necessary and eleven slots 1/32 inch deep and 1/16 inch wide were fitted as shown in Fig. 4. At the

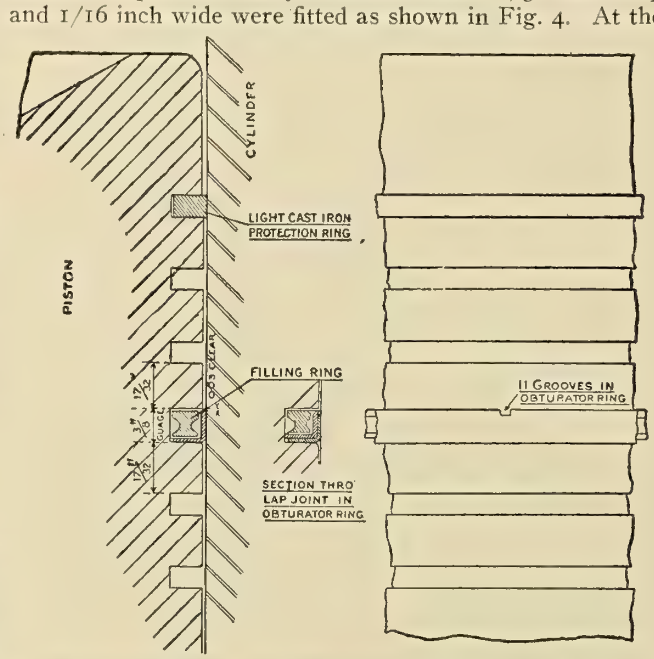


Fig. 4.—Unit Engine. Arrangement of Obturator Rings in Piston

same time the clearance between the edge of the ring and the piston groove was increased from 0.002 inch to 0.003 inch.

These slight modifications resulted in a distinct improvement and the ring worked satisfactorily with mean indicated pressures up to 140 pounds per square inch. No leakage was apparent, although the maximum compression pressure was very slightly less than that previously obtained with the full number of cast iron rings with the same compression ratio in use. There was a very decided knock in the piston at the end of the compression stroke, and after running for a total of about 30 hours it was decided to examine the piston and obturator ring. The obturator ring was found to be quite free and bearing generally and there was no measurable wear. The ring was therefore replaced and, in view of the previous knocking of the piston, two additional light cast iron rings were fitted below the obturator ring. These additional rings, which were intended to act as "buffer" rings, practically cured the knocking, but they must add slightly to the piston friction of the engine. It is probable that this knocking could have been avoided by reducing the piston clearance, but nothing could, of course, be done with the existing piston; neither was it desirable in view of running the engine at comparatively high mean pressures.

After running for about 150 hours at various powers, the obturator ring was again measured and the wear appeared to be about 0.001 inch, while the maximum wear in the groove of the piston when gaged was found to be 0.008 inch.

So far the obturator ring is promising, but it has been tested under very favorable conditions, and further experience is necessary before any recommendations could be made in regard to its general use in service engines. The original ring is still fitted in the engine, but there has been no opportunity to ascertain the actual reduction in piston friction resulting from its use. There is no doubt, however, that the engine is more free than formerly and its mechanical efficiency has been slightly increased. It is not known whether any experiments have been made to ascertain whether obturator rings would work satisfactorily when running over ports such as those fitted in two-stroke cycle engines, but it is probable that this will be tried at the laboratory at a later date.

Solid Injection

Very good results have been obtained with the "Unit" engine both with the solid and with the air injection systems. Instructions were received to carry out experiments with the object of reducing the tendency of the standard engines to smoke when using solid injection. A large number of tests were made and eventually smokeless combustion was obtained with the "Unit" engine at all powers from 100 brake horsepower to 25 brake horsepower, and the consumption of fuel oil at 100 brake horsepower and 380 revolutions per minute was just under 0.4 pound per brake horsepower hour. Having in view the fact that the tests were carried out with a single cylinder engine, fitted with a cam shaft driving mechanism designed for a multi-cylinder engine, this figure for consumption is remarkably good. The fuel used was shale oil having a specific gravity of 0.86 at 60 degrees F. During all these tests the fuel oil was very carefully measured, and it may be mentioned that during a six-hours' continuous test the variation in the consumption, recorded half hourly, was under 1 percent. The "Unit" engine is coupled to a standard Heenan & Froude dynamometer for absorbing the power.

Tests were made with the above engine when using air injection, and the fuel consumption at 100 brake horsepower, after making the necessary allowance for the power required to drive the air compressor, was practically the same as the fuel consumption when using solid injection.

Motorship Building in Europe

Six New 14,000-Ton Motor Vessels

BY OUR SPECIAL LONDON CORRESPONDENT

After a long period during which practically no information was given where it could be avoided, the Glen Line is now taking the public into its confidence regarding its big programme in connection with motorships. It will be remembered that Lord Pirrie is chairman of this firm and he is a convinced advocate of the oil engine, being at the same time chairman of Harland and Wolff, the largest motorship building firm in Europe. In addition to the seven 10,000 deadweight ton motor cargo ships

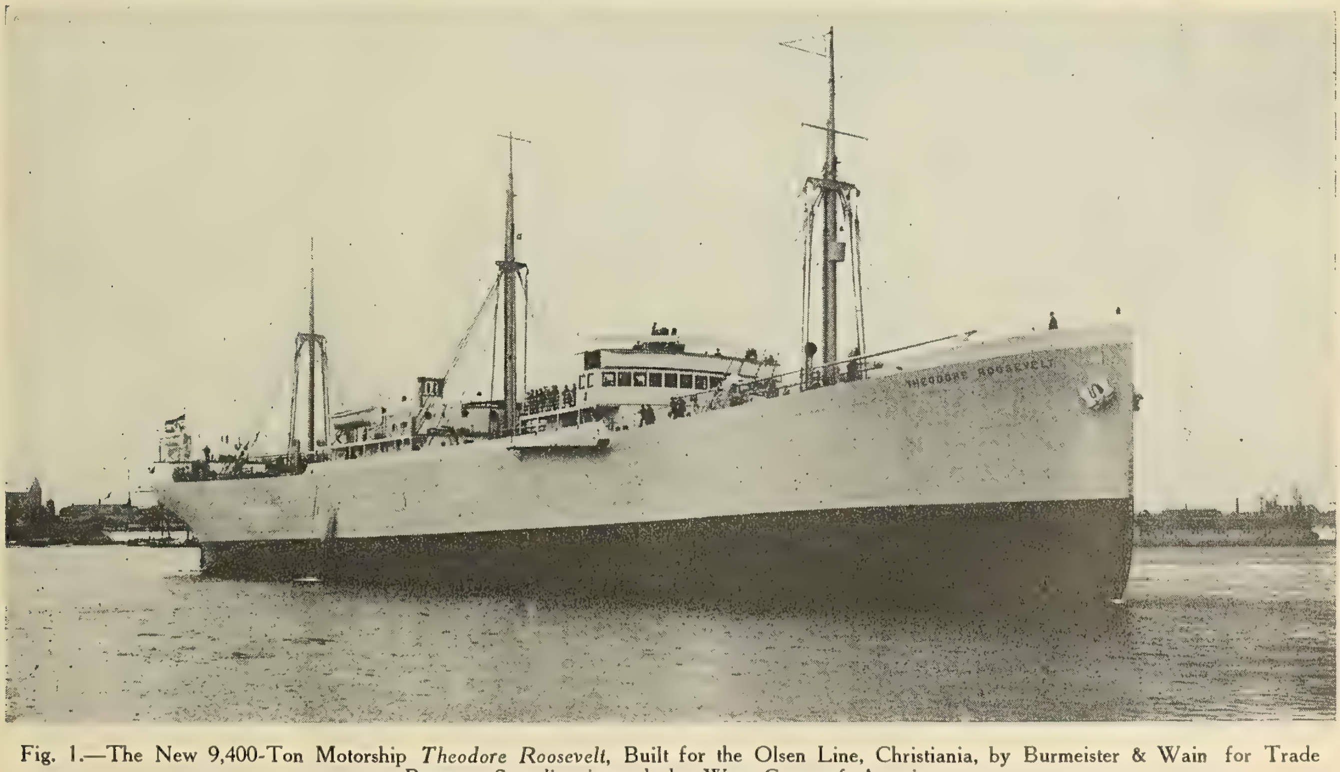


Fig. 1.—The New 9,400-Ton Motorship *Theodore Roosevelt*, Built for the Olsen Line, Christiania, by Burmeister & Wain for Trade Between Scandinavia and the West Coast of America

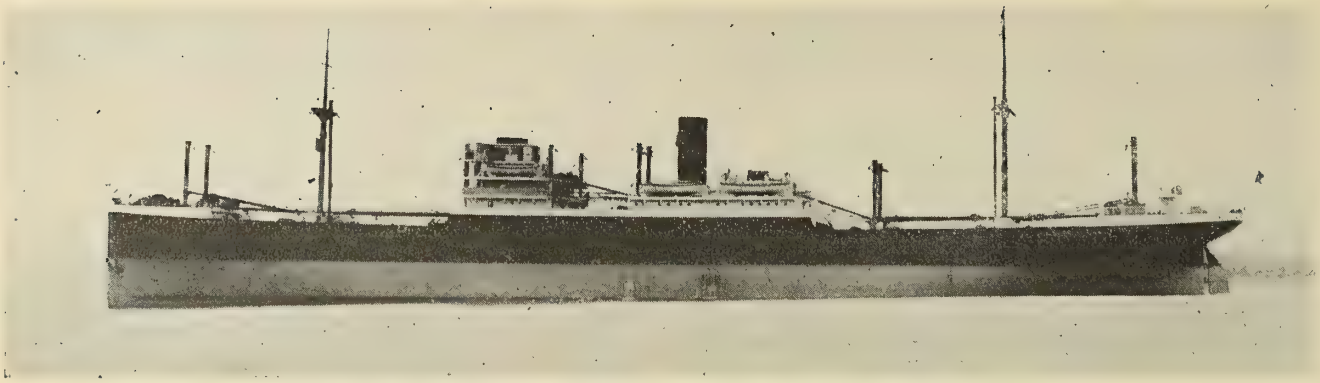


Fig. 2.—The New 14,000-Ton Motorship *Glenogle*, Built for the Glen Line

which are now in service, five more of these craft are to be built, while six 14,000 tonners will complete the immediate programme. The first of these larger ships has just started on her maiden voyage and the remaining five will follow at regular intervals of about six weeks or two months, all being produced from the Glasgow yard where motorship building is so standardized that motorships can be constructed more quickly than steamers and, it is stated, at a price very little in excess of reciprocating engined vessels. In no other way could this be accomplished than by a very advanced degree of standardization, for, as is well known, individual Diesel engine units cost a good deal more than reciprocating steam engines of the same power. The new works of Harland and Wolff at Glasgow are, however, so remarkably well equipped with new and special machinery designed essentially for oil engine construction, that the manufacturing costs are kept down to a manufacturing figure.

Some details of the first Glen Line 14,000-ton motorship have already been given, and it may be recalled that this vessel, the *Glenogle*, is 502 feet in length and is fitted with two of the latest type Harland and Wolff four cycle engines each of 3,200 indicated horsepower. It was found on the preliminary runs that the total fuel consumption including that for all auxiliaries worked out at under 20 tons per day of 24 hours for a speed of 12½ or 13 knots. The engines appear to run with the same ease and reliability as reciprocating steam engines, and the engineers state that there is no more work to do than on a steamer, while the number is much reduced, the engine room staff comprising only seven engineers and three electricians.

It is perhaps doubtful whether the best arrangement has been devised for the auxiliary machinery, which, in this as in nearly all the other motorships being built in Great Britain, is electrically operated throughout. The arrangement adopted is to provide four sets of 100-kilowatt Diesel driven electric generating sets. One of the objects sought is to run these sets at full load, no matter what the power may be, by subdividing them as required. This arrangement works perfectly satisfactorily in the ordinary way, but if every winch is in service for loading or discharging, it may be necessary to run all four dynamos at the same time—obviously an undesirable system. Moreover, the maneuvering compressors, of which there are two, are electrically driven by 180-horsepower motors, so that more

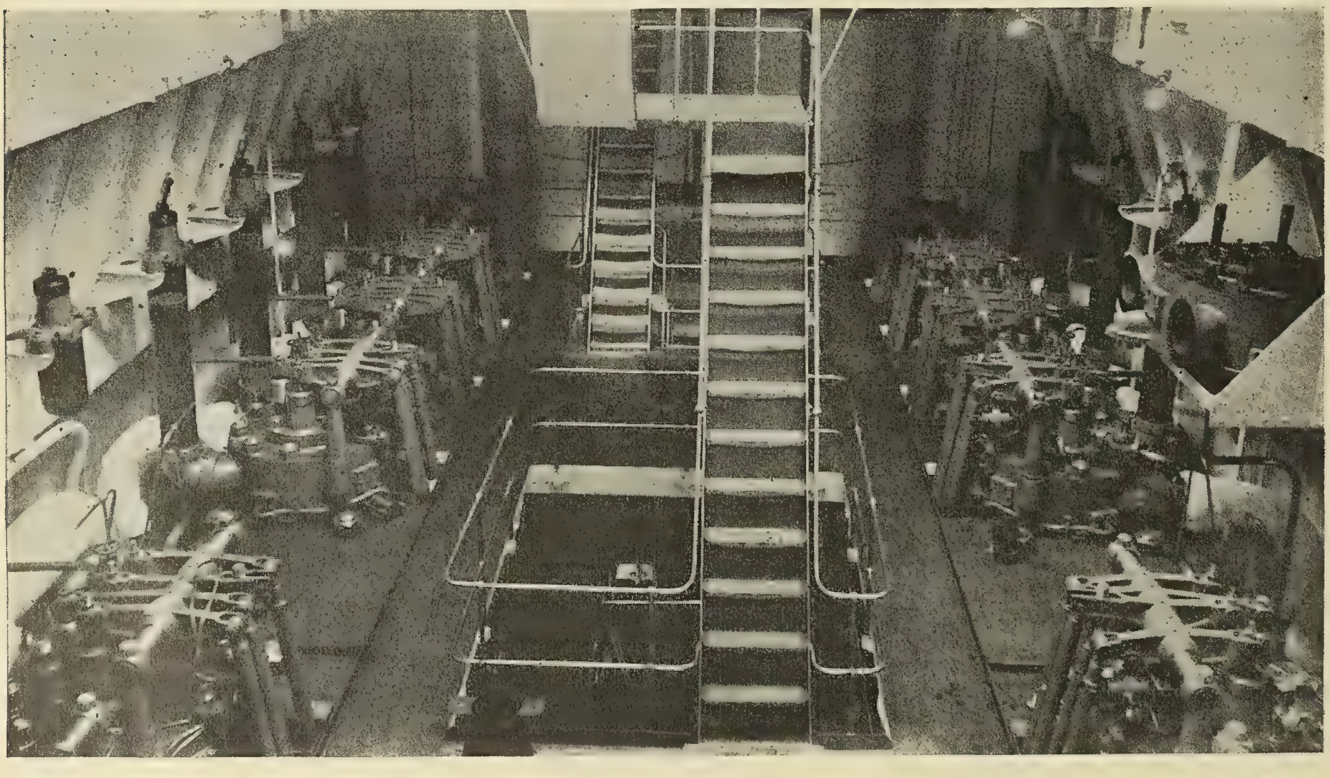


Fig. 3.—A View in the Engine Room of the 14,000-Ton Motorship *Glenogle*, Built by Harland & Wolff, Fitted With Two 3,200-Indicated Horsepower Diesel Engines

power is required by each of these compressors than can be delivered by any one generator. It may sometimes be necessary to have both these maneuvering compressors running, although one should be sufficient, so that on the whole it is doubtful whether the 400 kilowatts provided for the electrical plant is sufficient. In fact, it is more than probable that another 100-kilowatt set will be installed, but one is inclined to think that a better arrangement could be made by having a smaller number of higher powered units. Manufacturers of oil engines will understand the desire of the builders to maintain the 100-kilowatt set, as they use it not only in the large ships they build, but also in the smaller vessels. They are thus enabled to construct such plants in very large quantities, thus bringing down the cost of manufacture to a considerable extent.

Apart from this feature there appears to be absolutely no fault to find with these standard 14,000-ton ships, and it is worth noting that there is great competition to obtain one of the 12 berths for passengers on the new vessels, for the accommodation provided is infinitely better than is available on most large ocean-going liners.

A Motor Passenger Liner

The second vessel of this class will sail on her maiden voyage early in November and will be named the *Glenapp*. It will be remembered that during the war a motorship built on the Clyde for the East Asiatic Company, named the *Glenapp*, was taken over by the British Government and run by the Glen Line. She was recently returned to the owners, who sold her to the Elder Demster Line, by whom she was renamed the *Aba*. She has been fitted out with accommodation for 200 passengers and will start on her new life in the course of the next few weeks and thus be the first large motor passenger vessel to be put into commission. She will trade between Liverpool and the West Coast of Africa, and as she can maintain a speed at sea of 14 knots and is equipped with machinery of 6,400 indicated horsepower, she will probably be one of the most comfortable and serviceable passenger craft afloat. In addition she will carry a certain amount of cargo.

It will not be long before quite a fleet of motor passenger vessels is in commission, for the *Aba* will be followed in the course of a month or two by the first B. I. motor passenger liner *Magvana*, while the sister ship, the *Melita*, will be completed shortly after, both of these ships trading between London and Calcutta. Then a similar vessel for the Union Steamship Company, of New Zealand, trading between England and New Zealand, will be completed, followed by a large Swedish transatlantic motor liner and several Italian motor passenger ships. In spite of the shipbuilding slump, therefore, the motorship will evidently make great progress within the course of the next few months.

The Doxford Diesel Engine

The first of the 3,000 indicated horsepower Doxford Diesel engines has now been erected and tests will be commenced almost immediately, after which the engine will be installed in a 10,500-ton single screw cargo ship for Messrs. B. and J. Sutherland and Company, of Newcastle-on-Tyne.

In addition to the four engines of this type which Doxfords are building at Sunderland two more of exactly the same size are under construction in Sweden for Swedish shipowners who appear to be much taken with the Doxford design, since the Transatlantic Company of Stockholm has already ordered one motorship to be built in England fitted with a Doxford engine. The results of the tests of the first engine are awaited with the greatest interest by engineers, shipowners and shipbuilders, on account of the novel features in the design of the motor, which include solid fuel injection at a pressure of about 7,000 pounds per square inch, a compression pressure of only about 300 pounds per square inch (against 480 pounds with the usual Diesel motor) and the adoption of the opposed piston principle for the first time on a really large engine.

There are only four cylinders 580 millimeters diameter and 1,160 millimeters combined stroke, and in order that the compression pressure may be kept at a low figure, there is a special solid heat retaining top to the piston which is not water cooled like the remainder of the piston. The heat thus retained combined with the heat due to the compression of the air is sufficient to ignite the fuel even though the compression has not risen above 300 pounds per square inch. It is, however, necessary to heat the pistons before starting up, this being done by passing hot water through them for about half an hour before commencing the run. There does not, however, appear to be any saving in weight in this motor, for the 3,000 indicated horsepower set running at 77 revolutions per minute weighs well over 300 tons.

15,000-Ton Italian Motorship

The tendency towards the construction of larger ships is to be noted throughout the whole of Europe, and in addition to the 14,000-ton ships for the Glen Line, similar vessels are being built for the East Asiatic Company, while in Italy, besides the standard 8,100-ton class of motorship of which several examples have now been built and several more are on order, the Ansaldo San Giorgio Company has contracted for a 15,000-ton cargo ship fitted with 4,000 brake horsepower machinery. This vessel will be 511 feet 5 inches in length with a beam of 65 feet 6 inches and a load draft of 25 feet 11 inches. She will have a speed of 11½ knots and be equipped with two 2,000 brake horsepower six cylinder Ansaldo two cycle motors of the same type as those installed in the various Ansaldo engined vessels now trading between Italy and America. Their chief peculiarity lies in the adoption of controlled port scavenging, while another feature of interest is the interposition of a flexible distance piece between the cylinder cover and cylinder top, by which it is claimed that any possibilities of cracks are eliminated.

Motor Boat Show to Be Held in December

AT a recent meeting of the show committee of the National Association of Engine and Boat Manufacturers in New York, spaces were allotted for the sixteenth annual motor boat show to be held in Grand Central Palace, New York, December 10 to December 18. Leading engine and boat manufacturers were represented and the applications for space were so great that it is evident the record-breaking February, 1920, show will be repeated if not surpassed.

In February the exhibits totaled more than 100, and a good percentage of these showed boats of the pleasure and cruising type. This year there will be a much greater display of boats, both from manufacturers in this country and in Canada.

Stock model cruisers from as far west as Wisconsin will be on exhibition, and there will be a special display of speed boats, including several built to defend the recently captured Harmsworth Trophy.

Reports from authorities in the oil industry on the Pacific coast indicate that a fleet of tankers twice the size of the present fleet now on the Pacific will be needed during the next two years to meet the requirements for handling oil.

Reciprocating Engine Crosshead Design Applied to Heavy Oil Engines

BY W. D. FORBES

This series of articles on the design of reciprocating parts for heavy oil engines, of which the following discussion of the crosshead forms a part, is based on the author's extensive experience in the design and construction of high-speed auxiliary marine engines. Data on the power transmitting elements of the Diesel mechanism as opposed to the static units, such as the frame and crank case, are rather meager, so that where a similarity exists between such parts and those of the reciprocating steam engine, the same principles may well be applied to oil engine construction.

IF Sir James McKechnie's prophecy as to the position the heavy oil engine will hold in marine propulsion of the future is true, the study of the design of parts used in reciprocating engines may very well prove useful in the construction of similar parts in the oil engine. Because there is a certain relation between the various parts of reciprocating steam and reciprocating oil engines, I propose to discuss the various parts of the motor or engine which directly transmit the power in contra-distinction to the static pieces. The power delivering parts are the piston rod, crosshead complete, connecting rod complete and the crank shaft, while the static parts include the frame, crank case, cylinders and the like.

Crosshead Design

The first part to be considered is the crosshead, which, together with the piston and rod, has a right line motion as opposed to the crank shaft, which has a rotary motion, and the connecting rod, which at one end has a swinging as well as a right line motion and at the other a swinging and rotating motion combined.

The crosshead is the flexible point of connection which permits the right line motion to develop into the final rotary motion of the crank shaft. The first problem in the design of the crosshead is to determine whether the crosshead pin shall be supported at both ends and a single pair of brasses used or whether it shall be of the overhung type utilizing two pairs of brasses. In this case more metal is required to obtain a strength equal to that of a design which has a pin supported at only one end. Every designer well knows the usual form of overhung pin and the "spade handle" type connecting rod which accompanies it, as well as the nicety of adjustment which the twin brasses require. The overhung design of pin also requires four sets of liners together with bolts, lock nuts and cotterpins. In order that the four parts which make up the brasses shall wear alike, great care must be exercised in obtaining uniform material so that each bearing will last for the maximum period of service. The best practice is to cast twin bearings of the overhung pin type in the same heat, because in so doing a similarity of metals is assured.

Two Methods of Designing Pins of the Overhung Type

Overhung type pins may be produced in one of two ways: they may be turned on the crosshead pins, making the pin solid, or they may be turned separately and fitted to the crosshead, leaving the ends overhanging. The latter method, of course, demands a carefully drilled hole and a pin which may be turned to either a forced, shrunk or tight fit, which will permit the pin to be easily removed for renewal. If the pins are forged as parts of the crosshead they do not lend themselves readily to the hardening process, although it is possible to both harden and grind such a piece. Should the pins crack or break, however, the cost of reproducing the design is great and the loss in time serious, so that it is not the best method of constructing the crosshead.

If the pins are forged solid, the piston rod can be made to pass through the piece, which is a distinct advantage, as it allows the rod to be adjusted in line with the cylinder, or, if no adjustment is wanted, a taper connection can be made between the rod and the crosshead. If the pin is inserted, this through-hole for the piston rod is not as satisfactory, since the body of the pin must be enlarged to permit the passage of the rod through it without weakening it. Such a design, however, furnishes a solid anchorage for the pin. In speaking of the crosshead piece, it is intended that this part of the design shall not only carry the pin or pins, but also provide an extension to form the support of the shoes as well as provide the connection for the piston rod.

The cost of this design is excessive, and if the engine in which it is to be used is large, the grinding of the solid pins requires a large grinder to do the work, while, on the other hand, the inserted pins may be turned out on a smaller machine. Where the inserted pin is used, whether it is shrunk in place or a forced fit, there must be provided some means of preventing its turning should the brasses tighten on the pins. As the inserted pin has the advantage of being easily replaced, whatever means is taken to prevent the pin turning it should be such as to retain this advantage if it becomes necessary to insert a spare pin. The best method of obtaining this result is by fitting a key or, more properly, a feather to the crosshead piece, the keyway being in the pin. There is little tendency for the pin to work out of the crosshead, but to prevent any chance of this, a small set screw is fitted to it.

Drawbacks of the Overhung Pin Design

The objection to the overhung pin lies in the fact that there are two bearings which must be provided with oiling tubes and the like. Should the supply of oil fail in either bearing, serious breakdowns might result. There is double the chance of trouble with overhung pins for this reason. It is usual to provide a generous fillet where the pins join the main piece of the crosshead. Although this fillet provides increased strength and prevents cracking in hardening, it takes a certain amount of bearing surface from the pin. The brasses must be turned out to allow for the fillet quite liberally. To overcome this loss of surface, however, a right and left hook tool with a round nose should be used when turning up the pins, in order to undercut into the main piece of the crosshead, making a blind fillet, so that the sections of the pins which extend beyond the faces of the piece are entirely free from the fillet. The full length of each pin thus is made a bearing surface for the brasses. This system provides a greater overhang than if an outside fillet is used, and this fact must be borne in mind in deciding the diameter of the pin. If the pin is of the inserted type, the blind fillet is obtained by making the enlarged part enough shorter in the body to keep the fillets back of the faces of the main piece of the crosshead.

Method of Constructing the Main Piece of the Crosshead

In selecting the material of which the main piece of the crosshead is made, either steel castings or forgings may be considered. If the former is used, it will be found that the design is heavier than the forged crosshead. A casting, however, is much cheaper and quite reliable, although there is always the chance of flaws developing under the stress of service conditions, while forged parts present no such danger. For the grade of work required in marine Diesel engines, forgings are always advisable even at a greatly increased cost. The crosshead with a support for the pin must be made of two pieces if forgings are decided upon. If the entire crosshead is forged, it can be made lighter, although the cost in this case is increased over that of the built-up type. Whether the crosshead is forged or cast, the pin may be made in several ways—a straight pin forced or shrunk in place, a straight pin fitted to two supports and held in place by nuts on each end of the pin, or a straight pin with a head on one end and threaded on the other for a lock nut. In the latter case the threaded end may be reduced in diameter. The forced or shrunk-in pin has certain drawbacks that should prevent its choice, but if it is used the bearings at the ends should be wide and the holes in them should be of two different diameters so that they will not be distorted when the pin is forced into place. A small set screw should also be provided to prevent the possibility of having the pin work out. The advantage of having the pin held in place by a lock nut lies in the ease with which it may be replaced.

Only one short key can be used with the removable pin, and that must be made fast to the crosshead piece, the keyway being in the end of the pin. When a single pin is used, supported at both ends, it is evident that the upper end of the connecting rod can no longer be of the forked type, but must be what is often called a solid end. However, the construction of the connecting rod will not be discussed at this time except in so far as it is necessary to explain the construction of the crosshead.

Allowing for the Swing of the Connecting Rod

In order to have the ends of the connecting rod swing, the space between the two supports must be cut away. In the case of a casting, this is easily done by coring, while in a forging it must be machined away, which is a difficult operation and requires specially arranged machines. It is not necessary to work with a great degree of accuracy, although the two inner faces of the pin support must be parallel and smooth; the rest of the space is clearance. The method of connecting the piston rod to either the cast or the forged crosshead has been previously discussed, but it may be well to add that when a casting is used it is customary to tap into the metal for the piston rod, which is then threaded. Care must be taken in boring or tapping the hole to have the piston at right angles to the crosshead. The face of the head must also be carefully alined to the center of the piston rod. The latter may be corrected by filing or scraping if it is out of alinement, but if the piston rod and pin are not set at right angles, nothing can be done to correct the error and still preserve the measurements of the original design. In such a case the only way in which the defect might be overcome is to re-bore the crosshead pin holes.

To insure correct alinement of the piston rod, it is common practice to first bore or thread the holes for the rod in the pin, and, by screwing or fastening the rod in place, obtain the desired result by laying the rod in V-blocks on the platen of a boring mill, making sure, of course, that the V-blocks are adjusted at right angles to the boring bar.

Construction of the Foot of the Crosshead

In designing the foot of the crosshead, ample surface must be provided, especially in the direction of greatest wear, to preserve the surface in the best condition. A broad horizontal foot which is narrow vertically is not as good as the reverse. It is a well-known fact that a short surface reciprocating on a long one results in the shorter surface wearing convex and the long one concave. It is evident, therefore, that the crosshead shoe should be made as long as possible vertically in order to overcome this tendency, bearing in mind, however, that if the shoe is long it must be supported over its entire length to gain an advantage.

To my mind, it is poor engineering if a piece is added to a moving part when it may be equally well put on a static part, and this idea should be carried out in crosshead design. For example, the crosshead shoe should never be placed on the moving crosshead, as it may better be fitted to the face of the guide. In this construction there is a distinct advantage of lightness in the moving parts and also in decreasing the number of these parts.

Spade Handle Type Connecting Rod

In the designs which have been discussed, the pins have been an integral part of the crosshead, and we shall now take up the discussion of a design in which the pin is not a part of the main piece, but is, in fact, a part of the connecting rod.

The term "spade handle" has been used previously to describe the form of connecting rod having a forked upper end. The two forks of the rod in this case are connected by a pin firmly secured by shrinking, forcing or fitting it in place. It is also possible to make this pin solid; that is, to turn it up in the same way as are the pins in the crossheads of a locomotive. Special machinery is required to do this quickly, and the design is rarely, if ever, found in marine work. If the pin is solid, it is impossible of renewal, and when worn a new rod will have to be supplied.

It is difficult to renew shrunk or forced pins, so that it is preferable to use a fitted pin.

Modifications of Forged Crosshead Design

At this point is may be well to take up the modifications in the design of a forged crosshead in order to use a pin with a single bearing fitted to the connecting rod. In this instance either of two designs may be used; the first is one in which a box-shaped opening is machined out in the crosshead main piece to receive the pair of brasses which are passed into the opening from the sides. In order to assemble this design, the pin is passed through the brasses. The second method is to provide a front or bottom opening to the recess for the brasses which is closed by a piece of metal held in position by screws or bolts. The latter construction allows the brasses to be passed around the fixed pin in the connecting rod, and with this type pin this is the only design permissible. The opening may be made at the lower end of the crosshead piece or at right angles to it on the front. The latter position has certain advantages. If the opening is made at the bottom of the crosshead piece, bolts cannot be used, so that studs must be resorted to, and it is difficult to provide enough strength in these to take care of the strain which is put on them. Then, too, the sweep in the fork of the rod must be great enough to clear these studs, and the resulting cutting away of the metal is open to objection. If, now, the face of the crosshead piece is cut away to admit the brasses to be placed in position, the closing piece can be made with two or more ribs which fit into recesses in the crosshead, and very light studs only are necessary to hold it in position while at the same time providing sufficient strength. In any case, there are parts used which are liable to work loose and give trouble, and an engine should never be fitted with them when they may be eliminated.

When the box-shaped opening is cut out of the solid crosshead piece there is nothing to work loose and greater strength and compactness may be obtained than by the use of the open front or end system. This design should be adopted in spite of the fact that it is a little more difficult to make. The "eye," as it may be called, must be scraped to a sizing block in order to be sure that spare brasses will fit when installed.

Taking Up Wear in the Bearings

It is, of course, necessary to provide some means of taking up wear in the crosshead brasses in either system, and the wedge employed is usually ample to accomplish this. The common practice is to bevel the upper half of the brass to meet the wedge which is forced in by means of set screws tapped into the crosshead. Some means also must be provided to draw the wedge back in case of necessity, which is best done by having a shoulder screw passed through the crosshead piece and tapped into the wedge at the centerline. The forcing-in screws are placed at the ends of the wedge.

In order to hold the top and bottom brasses firmly in place, a single pair of brasses is often made with shoulders which fit over the main piece of the crosshead. At times these brasses are made without shoulders, for the wedge in the upper brass has a path machined for it, and, since the withdrawing shoulder screw passes through the crosshead and into the wedge, the brass cannot move sidewise. To hold the lower brass in position in this case, a pin is set into the bottom of the piece and a hole drilled to register with it in the lower brass. If the fitting has been properly done, however, there is little chance for side motion in the brasses, as the inside sections of the connecting rod forks prevent any displacement. Since the brasses extend a little beyond the crosshead piece, however, it is just as well to secure the brasses as described in order to have the connecting rod bear on the brasses, especially if an improper alinement gives a tendency for the brasses to shift.

Fitting the Shoe to the Crosshead

The general form of the crosshead piece in relation to the shoe, as previously described, is a flat surface as long as possible with sufficient width to provide an adequate wearing surface. To join this flat surface with the main piece of the crosshead, a web is made which should be extended to the top and bottom edge of the foot in order to support it firmly. This web may be made quite thin, since all the strength required is to overcome the compressive action of the piston rod and connecting rod thrust.

It is quite posible to forge the piston rod and crosshead together, and this design provides the greatest strength and lightness. It has, however, the disadvantage of requiring a complete new forging in case the rod is bent or worn badly. In spite of this fact, the solid design is so simple, light and strong that despite the disadvantage of expense I believe it to be the best possible construction.

Service Requirements of the Oil Engine

In the oil engine the danger of bending the piston rod is less than in the steam engine, as it it not possible to trap a solid body of condensed steam between the cylinder heads and the piston, since there is no steam to condense and the clearances are much greater. Wear is, of course, equally possible, and I believe that a piston rod fitted with a sleeve which can readily be removed would provide a design which would work well in combination with the solid forged piston rod and crosshead. This design has proved very satisfactory in steam engine practice.

I do not at all agree with the statement that the workmanship in the oil engine must be vastly superior to that required in steam engine construction. It is true, of course, that where high pressures are utilized the joints must be made with greater care than where lower pressures are to be resisted, and for this reason oil engine joints must be of a higher grade than those of the steam engine. In the parts which have been described, however, the construction is sufficiently good for any oil engine. In the fit of the piston and its rings, better work has to be done in oil engine practice on account of the greater pressures, as well as on account of the higher temperatures encountered. The power developed in any engine must govern the bearing surfaces, and if these are provided for there is no reason why the parts not subjected to the great heat and pressures should be better made than those provided in the steam engine.

Programme of Naval Architects' Meeting

THE twenty-eighth general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies Building, 29 West 39th street, New York City, November 11 and 12, 1920. At the professional sessions, which will begin at 10 A. M. each day, the following papers will be read and discussed:

THURSDAY, NOVEMBER 11

"University Education in Ship Construction and Marine Transportation." By Professor Lawrence B. Chapman.

"Launching of Ships in Restricted Waters." By Lieutenant-Commander Harold E. Saunders, C.C., U. S. N.

"New 20,000-Ton Tankers." By Harold F. Norton.

"Economical Cargo Ships." By Alfred J. C. Robertson.

"Notes on Rivets and Spacing of Rivets." By Hugo P. Frear.

FRIDAY, NOVEMBER 12

"Comparative Tests of Bilge Keels and a Gyro-Stabilizer on Model of the U. S. Aircraft Carrier *Langley*." By Commander William McEntee, C.C., U. S. N.

"Surface Condensers." By Luther D. Lovekin.

"Rules and Regulations for Freeboard." By David Arnott

"Recent Advance in Oil Burning." By Ernest H. Peabody.

"The Problem of the Hull and Its Screw Propeller." By Rear Admiral Charles W. Dyson, U. S. N.

The annual banquet will be held at the Waldorf-Astoria Hotel, New York, on Friday evening, November 12. Arrangements have also been made for an inspection trip on Saturday morning, November 13, to the yard of the Federal Shipbuilding Company, at Kearney, N. J.

The council of the society will meet at 3 P. M. Wednesday, November 10, in the Engineering Societies Building, 29 West 39th street, New York, and applications for membership should reach the secretary in time for proper consideration before this meeting. The question of increased entrance fees and annual dues will be considered at the forthcoming meeting of the society.

Some Notes on Cargo Handling

BY LAWRENCE B. CHAPMAN

In attempting to find a solution for the inefficiencies in cargo handling at marine terminals which tend to handicap this country in the ocean carrying trade, the author has made a careful survey of conditions at one of the principal American ports. Since the methods practiced here are quite typical of other ports, the following suggestions based on these observations will be found of value in determining the means that must be taken to improve terminal efficiency in general.

THE next few years are bound to be trying ones to the American merchant marine; mistakes are going to be made due to inexperience, competition is going to be keen from nations more experienced and better established on the sea than we are, and various unfavorable conditions under which our ships operate will have to be overcome.

Brokerage, management and port charges are pretty well fixed and little reduction can be made here. Fuel for a slow speed cargo ship is rather a small item, ranging from 10 to 20 percent of the annual expenses, depending on the number of voyages per year and the prevailing price of fuel. In a later article I shall consider at length the subject of fuel economy. With the rising price of fuel it is becoming a more important item than formerly.

The two large items of the annual operating expenses are capital charges, which include interest, depreciation, amortization, insurance, repairs and overhauling; and the cost of loading and discharging the cargo.

Speeding Up the Loading and Unloading of Ships

If we grant for the time being that our first costs are higher than our competitors' (which certainly will not be the case long) and that the freight rates are the same, obviously the only way for us to exist is, first, to increase the earnings by more "turn arounds" per year and then to reduce the cost of handling cargo. It is to these two features that I wish now to direct attention. The time of detention in port and the cost per ton of loading or discharging a cargo are closely connected. Any method used to speed up the handling of a ship's cargo accomplishes two results: it reduces the cost of loading and discharging and shortens the term of detention in port. Detention is by far the more important of the two, for it reduces the ship's earning capacity.

It is obvious to even the casual observer that the present methods of loading, discharging and handling cargoes in American ports are in many cases hopelessly inefficient and out of date; in some instances the methods used are the same that existed fifty years ago. It is true that labor conditions are at present almost out of control, and strikes followed by congestion in the ports and on the piers have been of frequent occurrence; yet with all these disadvantages the possibilities of improvement are prodigious.

Estimating the Rate of Handling Cargoes

By estimating the weights of the various drafts and timing the number of drafts per hour, I found that the rate of discharging and loading for the various piers of the port at which observations were taken varied between 14 and 34 tons per hatch per hour, with one striking exception where the rate was 70 tons per hatch per hour. In many cases only portions of the hatches were being worked at one time.

The following methods of handling were used: (1) The swinging boom where only one hoist was in operation. In many cases this hoist was used in combination with a skidway which extended from the pier to the ship's deck. The hoist hauled the draft up the skid and then lowered it into the ship's hold. This gangplank skid was always used where the space between the ship and transit shed was narrow and could be employed to good advantage in such cases. (2) The "yard arm" system where two hoists were fast to each draft, one hoisting from the pier and then slacking, while the second took up the strain and lowered into the hold. (3) Burtoning the cargo, i. e., one boom hoisting from the hold and landing on deck and a hoist on a second boom hooking on and lowering to the pier while the first returned for a new draft. In every case the burtoning system was the fastest, and it is the only one that should exist, except in the special cases enumerated below.

Delays in Discharging

The most serious delay was at the discharging end of each draft—in the hold in the case of loading and on the pier in the case of discharging. In discharging, the delay was largely due to the small area available on the pier for landing the draft. Frequently the draft was held suspended until the pier gang had removed the previous draft, as the narrow space between the ship and the transit shed only allowed sufficient room to place one draft at a time. A constant delay was occasioned by the two pier men waiting to catch the draft and then place it in a position favorable for loading to the hand trucks.

In loading, a long time was lost by the gang in the hold attempting to place the draft in the most advantageous position for stowage, or in waiting for a gang to be free to take charge of the incoming draft. Frequently in loading there was a long wait on the pier end for the shed gang to bring up freight. In one case there was just sufficient space for one load to be prepared at one time, and, as the burton system was being used, the shore hoist was always waiting for a load to be prepared and the hold hoist was waiting for a draft from the shore hoist.

In very few cases was there any attempt made to use the "reservoir principle"; that is, to have several loads at each place at the same time in order to keep the system in operation in case of local delays. Thus there was only one draft on the pier at one time available for the pier truckmen on the ship's hoist, and only one draft on deck available for the second hoist when burtoning, either to the hold or to the pier. The lack of these "reservoirs" caused frequent and needless delays. In nearly all cases there were two gangs of four men in the hold, two men on deck, two men on the pier, two winch men and nine to twelve truckers per hatch.

Possibilities of Efficient Methods

The case where 70 tons per hatch per hour were being handled deserves special mention, for the methods used were in sharp contrast to all the others; yet here only three out of four hatches were being worked at the same time, which shows that reduction in cargo handling expense was the object of the more efficient methods and not the reduced time of holding the ship in port between voyages.

In this case a cargo of uniform packages was being unloaded. The burtoning system was used, and there was no delay either in the hold, on deck or on the pier. Each draft from the hold was landed on deck, where there was space for several at one time, and the hold hoist immediately returned for a new draft. On the pier there was a raised platform opposite each hatch with space for two drafts on each, the ship's outboard hoist delivering alternately to the forward and aft ends of the platform. Electric trucks capable of carrying two drafts from the ship's falls removed the cargo from these platforms. At times the ship's hoist was discharging at a rate of three drafts per minute and sometimes even faster; yet there were no delays and the electric trucks removed the cargo to the shed as fast as it was discharged.

Suggestions for Improving Present Conditions

I offer below some criticism of the present methods and suggestions for decreasing cargo handling costs and reducing the detention of ships in port. Some of these are not new, as they have been proposed by our terminal engineers; nevertheless little attempt is being made to introduce even the suggestions already proposed.

The burtoning system of handling cargo, where one boom hoists from the hold and transfers the draft to a hoist on a second boom, which lowers it to the pier, is by far the fastest and most efficient. In special cases when working a cargo with a cargo mast on the pier, either to the first or second deck of pier, the "yard arm" system may be preferable.

The space between the transit shed and the ship should be wider than in many existing cases to give ample space for a "reservoir" so that there never will be a case where the truckman on the pier has to wait for a draft from the ship's hoist, or the ship's hoist has to wait for the truckmen to bring up a load. This wide space also allows room for a rough sorting of the cargo.

> There are still many people who for various reasons doubt whether we can compete successfully at sea with other nations. The reasons generally given for doubt are the higher first cost of our ships and the higher wages paid American crews. The bogy of crew expense always seems cropping out. A study of the operating costs of American ships shows that the wages and subsistence of the crew range around 10 percent of the total annual operating expense. Surely this is not the place to direct our efforts in cutting down expenses or to waste time worrying about competition. It is time that the public realized what a small percentage of the operating expense the crew actually is. A ship of 12,000 tons deadweight costs in the neighborhood of $2,000,000 and has a crew of between 50 and 60 men. When one stops to compare the number of men employed by an industrial plant on shore costing $2,000,000, it is realized perhaps more clearly that the labor cost on shipboard is, after all, a small item.—LAWRENCE B. CHAPMAN.

In many cases, especially with a uniform cargo as baled or bagged goods, or uniform boxes and the like, a raised platform on the pier is of great advantage for loading onto the pier trucks. In no case should time be wasted in swinging each draft into an advantageous position for loading on the hand trucks.

A "reservoir" station should be maintained on deck so that one fall will never have to wait for the other.

There is too long a delay in the hold in stowing cargo and locating exact position to land each draft. More men should be employed in stowing.

Wider and either longer hatches or hatches closer together should be fitted to obviate delay in stowing and unloading cargo under deck at the sides and ends of hatches.

Either two hatches with a boom serving each or a long hatch with a boom serving each end should be fitted to each cargo hold. A 14,000-ton deadweight ship would have eight hatches, and, if possible, ten or twelve booms serving these hatches at one time. With the burtoning system this would mean twenty to twenty-four booms and winches in operation at one time. This of course is the upper limit for a ship of this size (about 500 feet in length). It will be impossible to operate two hoists in one hatch at the same speed as one, unless the hatch is a long one, on account of interference and danger to the men in the hold.

Whenever possible, a pier should be constructed so that barges and lighters can lay along the side of the ship away from the pier and receive or deliver cargo for waterfront deliverance or for transportation by inland waterways. In this way double handling for such cargo is avoided and increased speed of handling is brought about without undue congestion in the transit shed.

Necessity of Installing Electric Auxiliaries

The extremely inefficient steam winch should be done away with and electric winches installed in their place. The current for these winches can be supplied either by shore current or a small Diesel electric set. This will greatly reduce the cargo handling cost and allow the fires to be drawn in all the boilers (except when needed for heating). This will have the further advantage of leaving the engine room force free, and as none of the steam power plant is in operation, overhauling can be easily carried out. There is no doubt that the steam steering gear and the steam deck winch are the two most inefficient pieces of apparatus on shipboard.

Electric trucks either with or without trailers should supersede the hand truck.

The transit shed should be equipped with overhead traveling cranes, monorail crane equipment, tiering machines, etc., for handling and assorting the cargo.

Railroad tracks with connections to the main track lines should lead to every pier or, better, the space between the transit shed and the ship. Trucks and teams should not be allowed within the transit shed except in a central driveway. With this layout the shed crane system can receive and deliver all freight to or from the cars or trucks, and the space within the transit shed is free for sorting and tiering of the cargo.

Many of the piers today are equipped with absolutely no crane service and the methods used in handling heavy pieces of freight are no different than those used in the days of the clipper ships.

Standard containers should be used to obviate the rehandling of small package freight and thus reduce the cost of handling all along the line.

"Stream unloading," as formerly used at Hamburg, should be given consideration in all new layouts. Wherever possible, all goods for waterfront delivery should be loaded directly onto lighters, and all goods for delivery by inland waterways should be loaded into barges alongside.

Two-deck transit sheds have many advantages—one deck for incoming and the other for outgoing cargo.

New Piers Fitted with Gantry Cranes

Traveling gantry jib cranes should be fitted on all new piers. These are especially useful for heavy pieces of freight. When the cargo consists of small miscellaneous freight these pier cranes can work in conjunction with the ship's booms, one swing of the crane to two or more drafts of the ship's falls. In loading, the pier crane can swing the draft directly from the pier into the ship's hold, leaving the ship's booms to swing into stowage. For small package freight where, on account of bulk, the draft is limited to the neighborhood of 1,200 pounds, two ship's booms served by electric winches would appear to be better than the pier crane. When the railroad track is on the outside of the transit shed, the traveling gantry is indispensable for loading and unloading cars. It is also useful in transferring goods into and out of the transit shed and for receiving and delivering freight for inland water transportation when a ship is not at the pier.

A scheme has recently been proposed that has some possibilities. It consists of cranes on dolphins outside of the ship. These cranes can deliver or receive either to the pier or to barges or lighters alongside the ship.

There should be a "getting together" of steamship companies, pier authorities and transportation interests for the quicker and more efficient handling of ship's cargoes.

Truck Congestion on the Pier

Obviously all methods to reduce detention are of no avail if a ship has to wait for a cargo or sail with a partial cargo. At one pier that came under my observation a large part of the freight for a ship's cargo was apparently being delivered by trucks in one day, resulting in a most hopeless congestion of trucks on the pier and in the street, to say nothing of long and expensive waiting of the trucks for an opportunity to deliver freight.

Everything should be done to improve the conditions of the longshoremen so as to speed up their work. Some sort of bonus system or piece work system should be introduced not alone to decrease handling costs but more especially to decrease detention in port.

Probably the best all around draft is around 1,200 pounds; loads larger than this are, as a rule, too bulky and require too long to prepare. With proper "reservoir" stations two drafts per minute could be easily maintained, say 100 per hour as a daily average. This would give 54 tons per boom system per hour.

Operating Records Possible

If a ship's hatches are sufficient in number (say eight for a 14,000-ton ship) and two boom systems are used at the larger hatches (say twelve per ship), 650 tons per hour can be handled. In a ten-hour day 6,500 tons should be handled, or a 14,000 deadweight ton ship discharged and loaded (28,000 tons) in 4.3 days. I realize that this is so far beyond the present practice that it may seem impossible; yet this is only at the rate of 54 tons per hour per hatch, while I have shown that 70 tons per hatch came under my observation. With two hoists working in a 35-foot hatch it would probably be impossible to maintain a much higher rate than 54 tons per hoist; yet with nine hatches and one hoist per hatch working at the 70-ton rate, practically the same rate per hour for the ship could be maintained.

If a rate of 40 tons per hatch per hour were maintained with a 4-hatch ship, the rate would be 1,600 tons per 10-hour day in contrast to the above 6,500 tons.

For an 11-knot, 14,000 deadweight ton ship on a 4,000-mile run (allowing 30 days per year for repairs, overhauling, holidays, etc., and increasing the time in port 10 per cent for delays), the slower cargo handling rate would give 9.8 single trips per year, while the faster rate would give 16.9 single trips per year. While these figures may be for extreme cases, and assume too theoretical conditions for labor, ports and land transportation facilities, etc., they nevertheless show the possibilities and point the way where profits can be made even at high first cost of ships.

Actual Records for Cargo Handling

The following loading speeds have been published from time to time and are of interest in connection with the above suggestions:

S. S. *Andrea Luckenbach* (loading), 14,290 tons deadweight capacity ; 450 tons per hour with twelve gangs of men, eight hatches and twelve kingposts in operation.

S. S. *Saxonia* (Boston), 190 tons per hour.

Stream unloading at Hamburg averages 250 tons per hour.

It should be noted here that the above shows the increase in "turn arounds" per year, but does not take any account of the reduced cost of handling per ton which certainly would result with increased speed of handling. This would further increase the profits per year.

What we need is a little study and attention to ship "turn around" and not the complete indifference too often existing today.

More "turn arounds" not only increase the shipowners' profits, but also allow a larger number of ships to dock at a given pier per year, thus reducing the pier overhead per ship and the dock charges to the shipowner.

Location of River Terminals

BY H. MCL. HARDING*

THE selecting of the proper site for the initial development of river terminals involves many considerations, but it may be said that the chief of all is the permanence of the substructure. The river frontage available for terminals at one inland river city extended for a distance of four miles. It was the desire of the city authorities that the first terminal units should be so planned, designed and constructed as to show the greatest possible net income return from the investment. There must, therefore, be the least cost of all the elements which go to make up a complete terminal.

If the first few units can prove that terminals are wholly self-supporting and add nothing to taxation, but rather produce an income with a reduction in terminal charges to the shipper and consignee, then the whole waterfront will be developed proportional to the demands of commerce and navigation. While it is true that the whole waterfront of this city may finally be improved, nevertheless the returns from the first unit will greatly influence the securing a continuous progressive development.

One location might require for a unit substructure fifty thousand dollars and another at a more difficult location four times as much to accomplish the same result. It frequently happens, however, that a desirable location near a civic center is rendered unstable by subsidence or sloughing of the banks. The following description of the subsidence of inland river banks is therefore written to secure economically the safety of river terminals, and may indicate how at a comparatively little expense the otherwise desirable location can be utilized and become permanent.

Subsidence

To insure the permanence and low cost of the quays and superstructures, often amounting to a considerable

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investment, more than the usual careful investigation was necessary than was possible by river commissions for river conservation, as the frontage for terminals is measured by hundreds of feet and for river conservation by hundreds of miles.

Many investigations, surveys and studies have been made of the waterfront of the city of Natchez and of the conditions at various cities along the Mississippi and intermediate bluffs and "highgrounds," also the banks of the Ohio River, of thc Missouri River and of the city of Cincinnati, and what was there found confirmed the following, that:

First.—The subsidence of waterfronts and levees, where there is no erosion but rather accretions, is due to the action of the continuous or intermittent flowing or seepage of underground streams washing or wearing away the subsoil at a greater or less distance below the surface of the ground, the water being either from springs, lakes or from some form of drainage.

Second.—That these waters flowing from high grounds such as bluffs bordering on the river, from lands at a distance back from the river or from ponds or springs, find at a low level one or more layers of clay or rock wholly or partially impervious to water, and the water in its downward movement having reached this layer, either follows a narrow course just above it, thereby causing a gully or bayou, or if not confined laterally, spreads out fan-like and conveys away in its course earth or sand, leaving voids or cavities in the subsoil above. Here and there may be left supporting columns of material which resist the action of the flow or are less easily transported by the water which normally has a slow movement.

There may be several impervious layers with porous and softer material between them, and there may therefore be separate streams at different elevations.

Third.—When the normal flow of water is small or at great depth, a long period of time may be required to produce a marked subsisdence of the surface—in fact, the superincumbent earth may form small arches which prevent for the time being any surface settling. Again, the depth may be such or there may be impervious material above and below the flowing water that there may not be any settling.

Fourth.—When the waters in the river rise, the voids or cavities are filled with water both from the back lands and from the river, together of considerable volume, but there is no apparent effect on the surface soil until the river begins to recede.

The layers of soft earth, often being sponge-like above the impervious layers, become saturated, thereby adding to the weight, and when the river flood waters recede, then, in combination with the back-land streams, the flow is augmented in volume and speed and more material is water transported. Larger, wider and more extended voids are formed, and then comes the subsidence, generally following the stages of the receding waters. Sometimes there is mud or earth, immovable unless saturated with water. When it becomes practically fluid it is often called "gumbo." When the columns or arches are slowly removed by the water, the subsidence is gradual, otherwise it may be quite rapid, often several feet in twelve hours or less. In some cases there are sand and gravel; in others this soft gumbo clay, which latter being saturated either flows out or else is squeezed out, but only when completely permeated with water.

The subsidence in swamps due to this moving of subsoil clay is not to be treated by the same method as the banks of rivers.

To the presence of flowing water from springs, from drainage from the rear, or from a combination of the above with river water during the receding of the high stage of the river is therefore due this river bank subsidence. The river water cannot be kept from the subsoil, if there are waters flowing from high back lands.

Typical Illustrations

There are numerous examples confirming the above conclusions.

In one case there was a layer of impervious blue clay (erroneously called soapstone) extending about 13 feet above the local river datum, covering a large area and of more than 80 feet in thickness. Above this layer of grayish blue clay was a layer of material probably 40 percent sand and the balance gravel, and above this another layer of sand and then marl of the Loess formation. The sand and the finer gravel of the strata above the clay was gradually carried into the river and the heavier gravel remained.

The flowing springs were not of sufficient volume or force more than to remove the sand and earth, but the gravel remained until the flood waters penetrated the upper layers and then these upper layers were also washed away, after which came the disastrous settlement of the surface. The flood waters and the trickling springs completed the destruction and finally at low water the high banks above the impervious layer were gone and there were clear springs of cold water flowing over the river beach through and over a bed of well washed gravel above the impervious clay, where formerly, before the sloughing, were 20 to 30 feet of sand, marl and surface soil.

The past history of this case is interesting. This waterfront property was about 600 feet in length along the river and several hundred feet in depth or width at right angles to the river, and was occupied by buildings and accessories belonging to a municipality owned public utility. Back of this property there were permanent bluffs some 150 feet in height.

There had been an unobstructed spring of water of some considerable volume flowing into the river through the northern portion of the property, but by means of filling and revetment the flow of the spring was stopped and there were accretions here instead of erosion.

The flow of water, which had been only a small seepage through the central and southern portion of the frontage, almost immediately greatly increased, and soon there was here an undermining, sloughing and a falling away of the bank forming a curve into the land.

Various devices were tried to prevent this sloughing away, such as with cinder filling, bushes, by concrete walls to keep out the river water, and other customary methods, the river alone being supposed to be the prime cause, but the efforts produced no good results, and the speed of falling away became greater and the buildings and whole plant were endangered. These so-called protective barriers were undermined by the flowing back-land waters, and the high stage of the river contributed to the final result.

At another place in front of other property along the same river, where for many years there have been a subsidence and then a falling away of the bank, there have always been springs of considerable volume. The water of these springs, though clear, cold and tasteless, yet must have been impregnated with iron, probably a chloride or hydrate, as the iron in solution cemented the sand and gravel and gradually formed a layer above the blue clay, preventing for a time subsidence. With, however, the washing away of the sand, this cemented layer also gave

(*Concluded on page* 933.)

Models and Their Lining Off

BY COMMANDER G. A. BISSET, C. C. U. S. N.

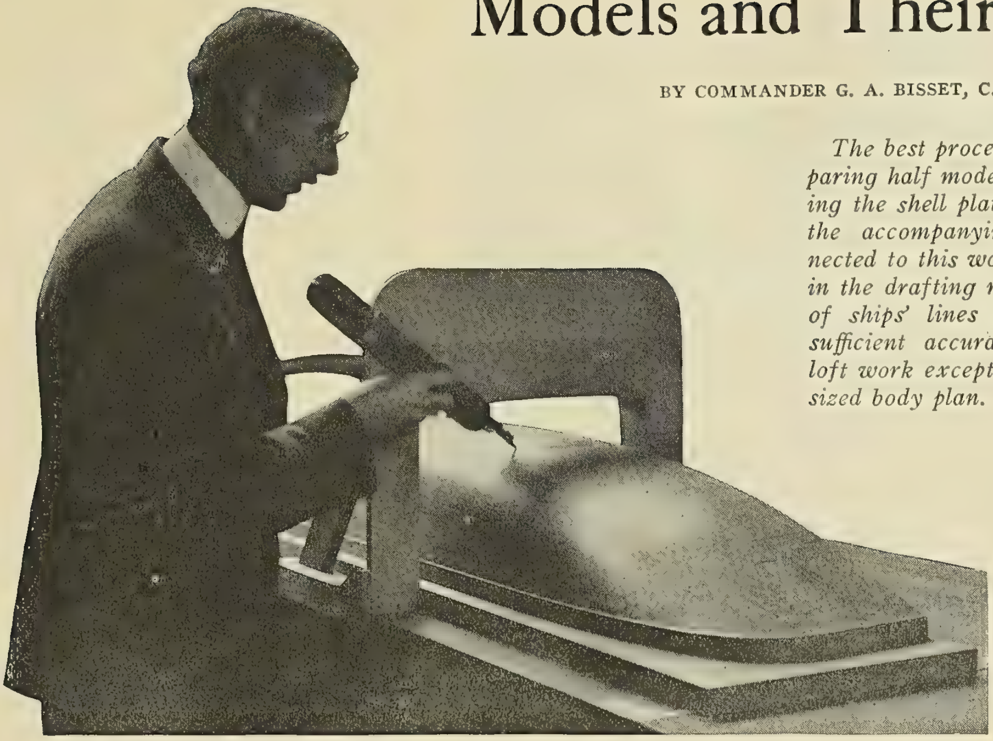

Fig. 1.—Actual Operation of Laying off Frames on Model Preparatory to Arranging Shell Plating

The best procedure to be followed in preparing half models for lining off and ordering the shell plates for a vessel is given in the accompanying article. Closely connected to this work is the use of glass slabs in the drafting room, on which the fairing of ships' lines may be carried out with sufficient accuracy to eliminate all mold loft work except the laying down of a full-sized body plan.

MODELS, or rather half models, of vessels are made in order that the shell plating may be ordered accurately to the dimensions required. On account of the curvature of the shell it is not possible to order this plating accurately from plans. Therefore, instead of ordering from plans and allowing an ample margin which would mean that there would be a considerable amount of scrap, it is considered much better practice to use a model, particularly at times such as the present, when the high cost of steel makes it imperative to keep the scrap down to the minimum.

Models are usually made on a scale of ¼ inch to 1 foot, although in the case of small vessels, such as tugs, ½ inch to the foot may be advantageously used.

The models are usually made in the pattern shop unless it is feasible to have them made in a shop attached to the Model Basin of the Washington Navy Yard, where special machinery for their manufacture is available. Thoroughly kiln dried sugar pine is the most satisfactory material to use, but No. 2 white pine will answer the purpose.

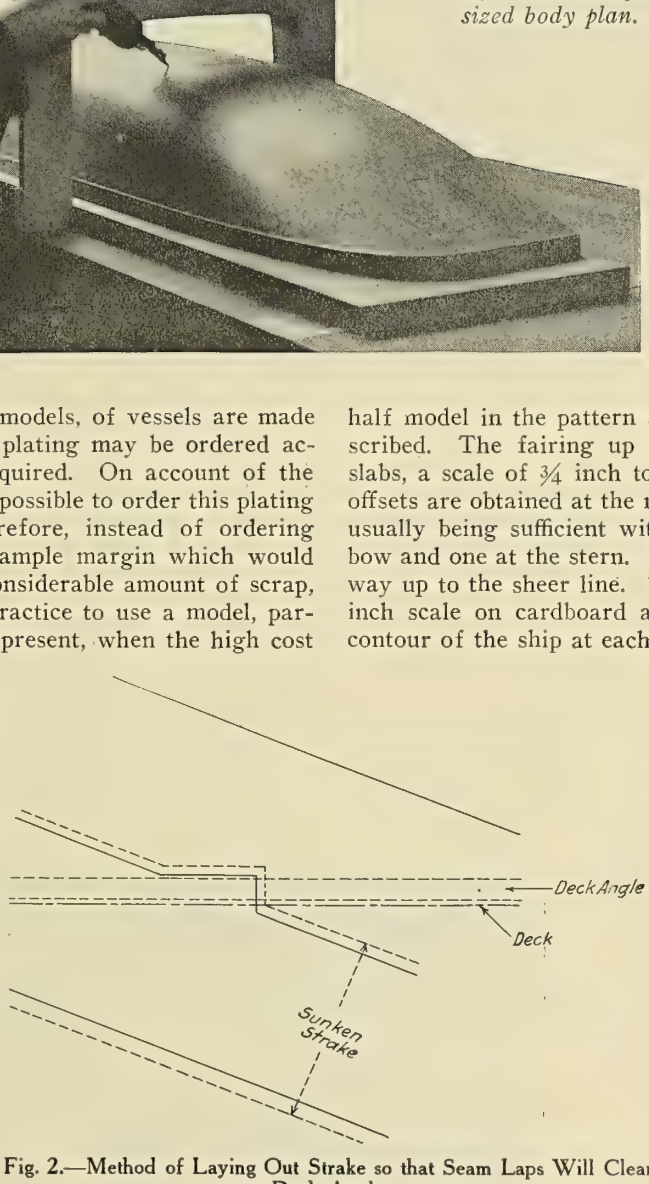

Fig. 2.—Method of Laying Out Strake so that Seam Laps Will Clear Deck Angle

Some time can be saved in ordering the material, if the model is made, in the case of vessels for the Navy, from the contract lines, in the Model Basin shop and sufficient accuracy is obtainable. If, however, any appreciable changes in the hull are contemplated, it is desirable not to start the model until the half breadth and body plans are faired up on the white glass slabs.

As in most cases it may be found necessary to make the half model in the pattern shop, the procedure will be described. The fairing up having been completed on the slabs, a scale of ¾ inch to the foot being used there, the offsets are obtained at the required number of stations, ten usually being sufficient with an extra half station at the bow and one at the stern. The offsets are obtained all the way up to the sheer line. These offsets are laid off to ¼-inch scale on cardboard and female molds made of the contour of the ship at each station. All the above is done in the drafting room.

These molds are sent to the pattern shop, which by this time should have completed the preliminary work of getting the material together, kiln drying it and glueing it together into a block large enough to make a half model of the ship with enough to spare so that the shape of the vessel may be extended ½ inch beyond the sheer line. This is necessary in order that the sheer line may be drawn in. In glueing the planks together to make the block, the contact surfaces of the planks are made to run horizontally—that is, parallel to the base line. The faying surfaces then become water planes, appearing on the surface of the model as waterlines. The pattern shop, having been provided with the molds and with the sheer, half breadth and body plans, proceeds to shape out the model. It is desirable to remind the shop that standard practice requires the bow of the model always to be *to the right*.

As soon as the model is completed, which should be in not over four days, it should be given two or three coats of clear—that is, white—shellac, not orange shellac. The

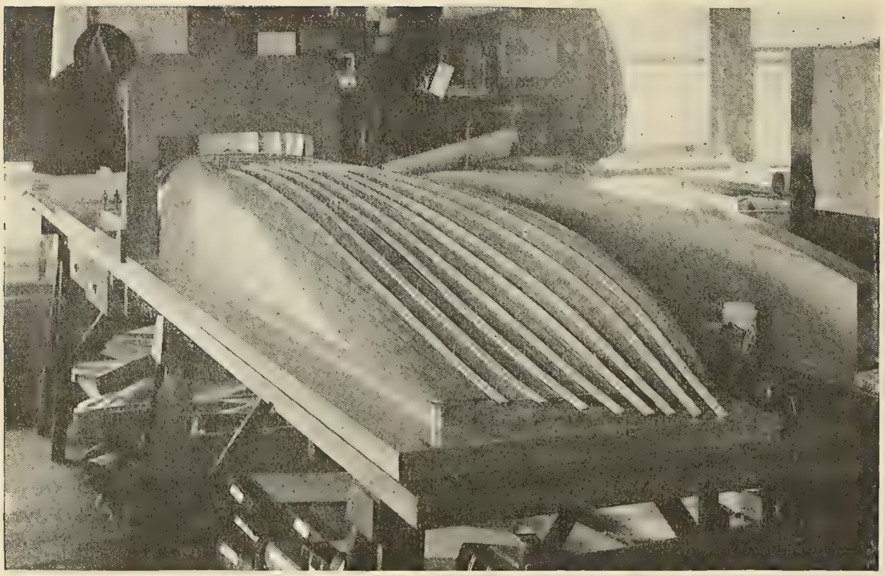

Fig. 3.—Battens Used to Line off Sight Edges of Shell Plating

shellac is applied (a) to make it keep its shape, (b) to prevent checking, and (c) to insure that the ink lines will not spread. White paint is sometimes used, but it takes much longer to dry than shellac.

The completed model is sent to the drafting room, where the lining off is done.

Lining Off

In lining off the model the carriage shown in Fig. 1 is used for putting in the frames. The bulkheads, decks, frames, etc., are first shown, then the keel, then the sheer strake, then the intervening strakes are laid off.

In laying off the other strakes much trial and error is resorted to in keeping the seam laps clear of longitudinals, decks, bilge keels, etc. Where these cannot be avoided they are jumped in the manner illustrated in Fig. 2.

Still more trial and error is necessary to obtain a good shift of butts. First a shift of butts is indicated for inner, outer and vertical keels and keel angles—that is (these angles having to shift butts also with each other), the butts in these keels are kept in different frame spaces. Next the port and starboard garboard strakes must have a shift of butts with reference to each other and the keel plates. In locating the butts in the other strakes of the shell it is desirable that three strakes intervene between strakes having butts in the same frame space. This point, however, is not so important towards the ends of the vessel where the bending moments in the vessel are not so great. Moreover, with the ever-present tendency to use wider and wider plates, it is becoming increasingly difficult to observe this ancient but important rule. As the lining off proceeds it becomes necessary to see that holes for air ports do not occur in frame spaces containing butts in the same strake. It is also important to avoid locating a butt within a frame space of watertight bulkheads or floors.

Later, when the inner bottom strakes are lined off it is desirable to get a shift of butts with reference to the outer bottom, and in the case of a vessel with a complete inner bottom extending up the sides a model similar to that for the outer bottom is necessary for ordering the material.

Fig. 3 shows the method of lining off sight edges of shell plating on the model.

Practical Hints

In laying off the shell plating on a model, the following points should be considered:

(a) The widths of plates that require furnacing should be kept within the capacity of the furnace—that is, normally they should not exceed 9 feet. To facilitate handling, such plating should be kept as short as possible.

(b) The length of plates that require rolling should not exceed the capacity of heavy plate rolls, usually about 30 feet is the maximum length.

(c) Plates other than the above should not be so wide as to be beyond the capacity of the punches in the shipfitters' shop.

(d) The length of plates should not be so great that the weight will exceed the capacity of the shop handling appliances, or such that the layout of shop tools will not permit them to be handled. Plates 36 feet long are ordinarily the longest that can be readily handled.

(e) Plates should be as large as shop facilities will permit in order to save riveting.

Ordering Material

In ordering plating from the model it is customary to add to the dimensions lifted from the model ½ inch to the width and 1 inch to the length. In case the plate as actually shown on the model is not quite rectangular, effort being directed to keep them as nearly rectangular as possible, it is the practice to order the circumscribing rectangular plate. In other words, sketch plates are not

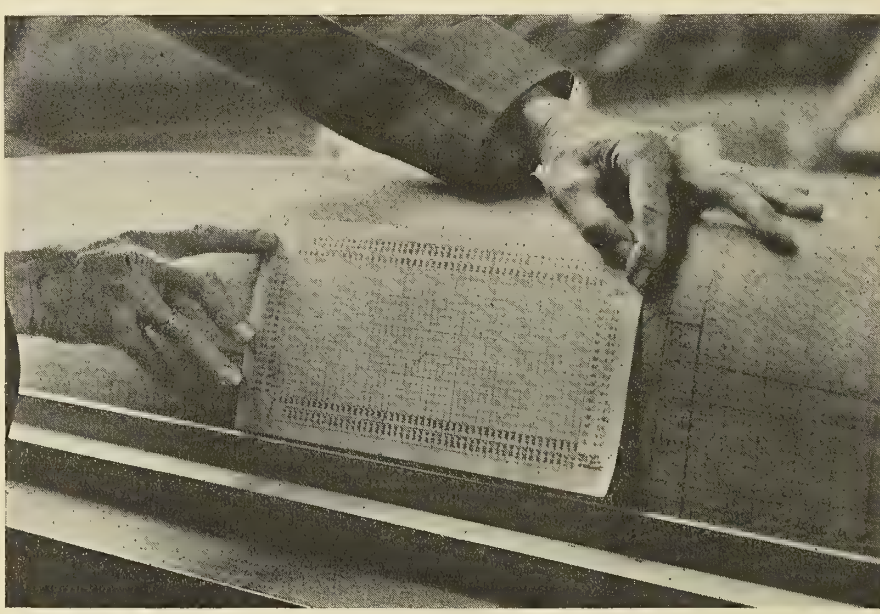

Fig. 4.—Laying Out and Taking Off the Shell Plating from a Model Showing Transparent Scale Used for Getting the Overall Dimensions of Plates

ordered for shell plates, except possibly for a few plates at the bow and stern where the scrap would otherwise be excessive.

Fig. 4 shows a method for obtaining dimensions of plates from the model.

Glass Slabs

Intimately connected with the use of models are the glass slabs that should constitute part of the equipment of every up-to-date ship drafting room. When the order to construct a vessel is received the first work undertaken is the fairing of the lines on the glass slab. Two glass slabs are required in the drafting room, preferably honed on both sides. For ordinary work slabs of the following sizes are required: One 54-inch by 54-inch and one 54-inch by 96-inch. These glass slabs, 1 inch thick, may be purchased from the Pittsburg Plate Glass Company under the following specifications: "Carrara Novas sanitary white glass, to have a honed finish on both sides and to be free from scratches, bubbles and all other defects which would render the honed surfaces unsuitable for drawing purposes. Edges need not be ground, but should be true enough to allow placing of each piece in separate wood frame."

The square slab is used for laying down the body plan, and the rectangular slab for use in laying down the half breadth and sheer plans.

The body is laid down to a scale of ¾ inch to 1 foot, the half breadth and sheer to two scales, the vertical scale being ¾ inch to 1 foot and the horizontal scale ¼ inch to 1 foot.

The "stations" are first laid down and faired up and molds made for the use of the patternmaker in making the half model of the vessel. The frames, waterlines, etc., are then faired. Later, the sight edges of the shell plating are faired, in connection with lining off these sight edges on the model.

After the fairing up is completed on the slab, tables of offsets are prepared and turned over to the mold loft for use in laying off the body plan full size. When, in the fairing up in the mold loft, errors are found in the lines taken from the slab, the table of offsets is corrected to agree with the mold loft fairing up. Very few corrections are usually necessary. Such corrections as are made usually occur in the vicinity of the tuck plate—that is, far aft where the frames have a considerable curvature near the upper part of the stern post.

It is found that great accuracy can be obtained by the use of glass slabs which have a snow white surface. It is necessary to use 9H lead pencils, 6H making too wide a line. Much better results are obtained with these slabs than could be obtained by use of drawing paper, which is much influenced by moisture, buckling badly over night, so that satisfactory accuracy cannot be secured.

While formerly lines of the vessel were faired up in the mold loft full size, a great deal of labor being involved in walking over this large area, satisfactory fairing is now done on the glass slabs in much less time at a much lower cost. It is now necessary to lay down in the mold loft, full size, only the body plan.

In connection with the use of the slabs a set of splines as follows will be required:

Six hard-rubber splines, 24 inches long.
Six hard-rubber splines, 36 inches long.
Six hard-rubber splines, 48 inches long.
Six hard-rubber splines, 60 inches long.

Location of River Terminals

(*Concluded from page* 930.)

way and then the action of the water was therefore the same as elsewhere on the layers of sand and marl. These layers of cemented material as exposed were from six inches to a foot or more in thickness and were of a deep reddish brown color.

In a location in front of another city, while there was being deposited a foreshore in front of the bank, gradually adding land, and with no erosion or sloughing of the banks, yet the levee and the land back of the levee were continually settling, even to the rear side of a marginal street which extended for a considerable distance parallel to the river bank.

There was in past years a subsidence of the southern portion of the levee, necessitating a constructing of other levees further inland and parallel to the first levee. The levees were very unstable. A large drain was dug for diverting the drainage from this southern portion of the city to a point below the southern limits of the city, and since then there has been no change in the elevation of this levee or any surface movement, and it has been permanent for the number of years since the drain was dug.

In the northern portion of the city no such sub-soil drain parallel to the river has been dug, and there is here a continual subsidence to this day.

Many other examples, the result of inspection and surveys, will later be given with a more satisfactory discussion.

Conclusion

The above, however, only comprises one feature among many as to securing the safety of future terminals. A large amount of money is now being appropriated to try to render safe a new river terminal poorly located.

From a study of results it is recommended:

First.—That there be borings made where possible to the depth of the layer of clay, rock or other impervious material to determine its existence and the presence or absence of flowing water. These borings should be made along a line to the rear of the area affected and parallel to the river. Sometimes the streams flow into the river below its surface and their presence can only be determined from the borings.

There should also be borings along lines at right angles to the river along the sides of the area or property as the water may enter from the sides.

These borings should extend to the impervious layers, which generally are not at great depths.

Second.—If water be found at a reasonable distance below the surface it should be confined and diverted by drains into the river so as not to spread and flow unconfined under the area affected. The drains may be composed of porous drain pipes with open joints laid in broken stone, and along the rear of the areas to be protected. Drains should also be constructed and connected at right angles to the rear drain, that the streams may flow without damage into the river.

To explain the details, exceptions and conditions which might occur and which could only be determined by a survey would require a long report.

Third.—There should be lines of stakes parallel and at right angles to the river, carefully levelled and in straight lines to determine the area of subsidence and any surface movements in any direction unless these have already been determined.

The above is only a rough outline of what should be done and naturally is subject to criticism as being incomplete, but from continued observations there is no doubt but that flowing waters or springs with the flood waters of the rivers form one source of surface subsidence.

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WE GUARANTEE that of this issue 9,400 copies were printed; that of these 9,400 copies 7,573 were mailed to regular paid subscribers, 442 were provided for counter and news company sales, 408 were mailed to advertisers, 79 were mailed to employees and correspondents, and 898 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 108,450—an average of 9,859 copies a month.

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Loss of Efficiency with High Speed Propellers

WITH the introduction of steam turbines and internal combustion engines higher speeds of rotation of the propeller shaft have been accepted together with the loss of propeller efficiency that goes with it. Though this unavoidable loss of efficiency is well known, the reason does not appear to be so well known. Of course, the final answer to the question is that both experiment and practice show that a smaller pitch ratio involves loss of efficiency; but the question remains, why? The answer is friction and interference. The surface friction increases with the square of the velocity; that is to say, with the square of the number of revolutions for the same diameter. The blades of the propeller follow each other closer and the interference is greater. The effect of interference is well known from the comparison of two, three and four bladed propellers, the greater number of blades showing marked decrease of efficiency.

Increasing the Power of Diesel Engines

THE Diesel engine has been thoroughly adapted to marine propulsion and is regularly built both in America and Europe to such sizes as will develop three hundred horsepower per cylinder where running at a convenient speed of revolutions. This readily gives eighteen hundred shaft horsepower for a six cylinder engine. For smoothness of running, the six cylinder engine is ideal; eight cylinders give a somewhat more even turning moment but lack dynamic balance.

To increase power three expedients have been used—twin engines, gearing and the use of two cycle engines. There seems no reason why we may not expect a considerable advantage from the use of the two cycle engines; a number are in successful use, though as yet lacking the efficiency of the four cycle type. Gearing, of course, admits of higher speed, which, however, brings its own troubles. The use of twin screws, though more expensive, has been accepted for many of the larger ships; it cannot be made advantageous when steam engines are replaced by Diesels. The natural and desirable line of advance is to increase the size of the cylinder. As has frequently been pointed out, the difficulty is the disposition of the heat absorbed by the cylinder walls because the area does not increase in proportion to the volume, while the thickness of the metal must be increased.

It is reported that European builders are ready to supply four cycle engines to develop five hundred horsepower per single acting cylinder, and American engineers are seriously considering the matter. An idea worthy of consideration is the use of some special metal that can endure greater stress under the conditions of service for cylinder liners.

Recommendation for Purchasers of Fuel Oil

IN another column of this issue there is a recommendation that fuel oil should be sold on guarantee with proper analysis and reports by experts, and that companies selling such oil would find it good business to adopt such a policy. Just now, when there is a shortage of all kinds of fuel and when purchasers take what they can get and pay what is asked, may seem a poor time for urging that policy, but the policy is correct and will probably be adopted in the near future. The idea is not new, as purchasers of large quantities of coal have bought on specifications. There may be a question as to who should issue specifications and whether experts should be employed by the users or the producers, or whether independent experts would be preferred. The oil companies do and must employ competent experts, and it is believed that coal companies would find it profitable to do so. Corporations that need experts can afford to have the best, and, having the information for their own use, can most economically furnish it to the public. Some of the best scientific men in the country are in the employ of corporations, and it is to the advantage of both sides that such men should be given prominence; their reports concerning the properties of products of the corporation would command acceptance.

Business Secrets

THIS is a plea for greater frankness on the part of engineers and manufacturers, as a matter of policy for their own advantage. There is a very proper idea that a man may well keep his private business to himself and that corporations may well practice a like reserve. But when a man wants to sell something it at once becomes a matter of business to the purchaser. He wants to know all about it, and the more intelligent he is the more he wants to know, especially as the old Roman precept *caveat emptor* carries right down into modern business. There are, of course, instances in which the purchaser may well use his purchase without too much curiosity; the average man had best wind his watch regularly and think no more about it till he wants to know the time. But usually a machine needs intelligent care, and the more the user knows about it the better service he will get from it.

Consider also the futility of excessive reticence. Intelligent users of various materials and machines already know a great deal about them and are keen enough to find out more. A certain concern bought a steam turbine and the engineer told his assistant to take certain measurements before it was erected. The erector sought to forbid this, but was informed that the machine belonged to the purchaser. Finally the builder sent blue prints of *another sized turbine* without dimensions. In less than half an hour the inquisitive engineer knew what turbine was represented by the blue print and what the scale of the drawing was.

Motorship Auxiliaries

THE installation of Diesel engines on ships at once brought the problem of the auxiliaries, including heating and cooking. Some of the earlier ships carried donkey boilers and had a full equipment of steam auxiliaries; and that method has advantages especially if the donkey boiler is set on an upper deck. The custom now is to provide an adequate electric plant with two or three Diesel driven generators; except on the smallest ships it is probably best to have three sets, one of which may be in reserve; and also it is very desirable that one set at least shall be on an upper deck, so that it may serve should the engine room be flooded.

It is long since electrical power was under suspicion; now properly designed and built electrical machinery is entirely reliable, requiring the minimum of attention. The auxiliaries on a motorship include pumps for all purposes, steering engine, cargo winches, anchor engine and capstans. Such auxiliaries are now regularly placed on the market and serve their purpose, though it is doubtful if any device is quite so satisfactory as the steam anchor engines or steam capstan. The steam engine has the advantage that its pull on cable or line is practically independent of speed; if line or cable comes too hard the engine will stall and start again when the line slackens. If engine and line are properly adapted to each other there is no danger of breakage.

We are so accustomed to the use of steam auxiliaries that they are accepted as a matter of course with all their wastefulness and inconvenience. Steam pipes in living spaces are a nuisance, and on deck waste more steam in heating the universe than they use for work. They are liable to freeze and give trouble when carried through bulkheads. Since steamships use ten or fifteen percent of the gross steam in the auxiliaries, the waste is a matter of importance; if it could be cut in half it might be able to keep a ship in commission when freight rates threaten a disappearance of profit.

The wastefulness of steam auxiliaries is well known, but may not always be appreciated. Large steam-pumps running at full capacity use sixty pounds of steam per horsepower hour; small steam pumps use from a hundred to a hundred and fifty; at reduced speed they may use double the amounts quoted. Nobody will quote the steam per horsepower for direct acting steam air-pumps, because no one knows for sure what the indicated power is. Their percentage of the main engine power under proper conditions may be so small that the steam consumption may escape notice.

The question of electric drive for auxiliaries on a steamship should be thoroughly worked out and advantage taken of the economy that may be possible. Considerable progress in this direction has already been made on warships.

Inland Waterway Transportation

AS an aid in overcoming the serious delays which exist today in the transportation of package freight and also as an aid in reducing the cost of transportation, William T. Donnelly, consulting engineer, New York, outlines elsewhere in this issue a new plan for the prompt dispatch of cargoes by inland water routes. This plan comprises a complete system of transportation by means of which the freight is taken direct from the point of origin and transported direct to the consumer. Briefly, it is proposed to transport the freight to a suitably equipped terminal on the nearest waterway by means of automobile trucks propelled by storage batteries. At the water terminal the freight is mechanically transferred from the trucks to a fleet of electrically propelled non-sinkable barges, the power for propulsion of the barges being supplied by an electrically propelled vessel carrying electric generating machinery of ample power. Upon arrival of the barge fleet at its destination, cargo for immediate delivery will be transferred from the barges by suitable mechanical appliances to electrically-propelled trucks for delivery direct to the consumer. In the case of cargoes not destined for immediate delivery the barges will be unloaded at a specially designed warehouse built on piling over shallow water. From the warehouse the freight can subsequently be delivered by electric trucks direct to the consumer. The various units which it is proposed to use have all been tried out and proved both practical and economical. As a matter of fact, the application of electricity to all the movements of freight in this system of transportation can be made with the same high operating economy as that obtained in central stations ashore or with the multiple unit trains on electrified railroads.

In proposing this plan of transportation, two objects of vital importance are sought—rapid dispatch of shipments and low cost of transportation. As an example of the feasibility of this system and the benefits which can reasonably be expected, Mr. Donnelly analyzes a specific case involving the movement of 800 tons of package freight in a fleet of four barges and one power boat between Schenectady, N. Y., and New York city at a speed of 9 miles per hour, showing that the cost of transportation to the operating company by this method is less than half the lowest freight rate and that the time of delivery is equal to that by express or motor truck under normal conditions and at least one-fourth of that by freight at the present time. In view of these benefits and the fact that this system of transportation provides a complete and independent service between the producer and consumer, the possibilities for its application wherever waterways, including canals, rivers, sounds and bays, are available are obviously manifold.

NEW BOOKS

Motor Boats and Boat Motors

REVIEWED BY C. H. PEABODY, DR. ENG.

Motor Boats and Boat Motors. By Victor W. Page, M. S. A. E., and A. Clark Leitch, N. A. Size, 6 by 9 inches. Pages, 524. Illustrations, 374. New York, 1920: The Norman W. Henley Publishing Company. Price, $4.

This book gives a popular exposition of boats and their motors for the owners of various classes of motor boats and pleasure boats. The range is large, since internal combustion engines are used for multifarious purposes by many people such as lobster-men, oyster-men, seiners, trawlers, coasters and freighters, together with a swarm of pleasure seekers in all kinds of motor boats and yachts, including hydroplanes and flying boats. The owners of all such craft are admonished to know something of their boats and engines, to the end that they may avoid trouble, or, being in trouble, to know how to get out of it.

A chapter is given by Mr. Leitch on the design of five popular types of motor boats, i. e., the tunnel stern boat, the V-bottom boat, the hydroplane, a 25-foot cruiser and a 16-foot general utility boat. This chapter has a purpose in that owners of boats should know enough of the construction and outfitting to be able properly to appreciate their boats. It is written as though amateurs were expected to build boats of the types illustrated from the instruction in the text. This is a good deal to expect of an amateur even had this chapter been expanded to the bulk of the entire volume.

All the rest of the book is edited by Mr. Page, the material for the several chapters being furnished by various experts. Attention is called to the fact that boats of moderate size are now comparatively inexpensive on account of standardization and quantity production, but even so, the purchaser is cautioned to beware and not buy a cheap boat. Such advice is good, as an amateur will have troubles enough with a good boat and motor. The prospective purchaser is advised to make up his mind exactly for what purpose the boat is to be used and what speed is desired; good advice, which may be best followed by an amateur who has had experience.

An important matter which may be new to some is that planks below the waterline may best be nailed with galvanized steel nails, a method said to be adopted for United States naval craft and one that is both economical and reliable; above the waterline copper riveting is advised.

Various types of open boats are illustrated—round bottom, flat bottom and dory type; also cabin boats that are probably dignified as yachts by the owners; and, further, there are types of speed launches and hydroplanes.

Chapters are given on hull construction and fittings. Excellent advice is given against overloading open boats. A rule to limit the number in quiet water to those that can be comfortably seated is not too drastic, nor the further advice that only half that number should be carried in rough water. Even better is the advice that an open boat should not be handled in rough water to send waves or even spray over the bow or sides. To follow this advice the skipper should be weather wise, lest he find he must drive his boat against a rising sea. The equipment with tops and spray hoods is convenient, with anchors if necessary, and with life preservers, horn, bell, lights and fire extinguishers is peremptorily required by law. It is at least convenient to have a compass and a log, and a sea anchor may be the last resort if caught in rough weather.

A further chapter gives the usual maritime customs and regulations for steam and other power vessels, as well as instructions for navigating by chart and buoy and for sailing by landmarks.

The second part of the book on motors and auxiliaries begins with an elementary explanation of two and four stroke engines, followed by illustrations of crank arrangements and firing orders for various types of multi-cylinder engines. Advice is given as to the choice of type and size of the motor, with a table of power capacities and speeds of various types and sizes of motor boats. Nine different well-known makes of motors are illustrated, including outboard motors and small Diesel engines; the latter type is described at length and its economy and other advantages are clearly pointed out. At present, however, such motors are not available except for sizeable yachts.

The proper working, or, in fact, working at all, of an internal combustion engine depends on a multiplicity of small details, any one of which may fail and stop the motor. Eternal vigilance is the price of motoring on land or sea, and a hundred pages is not too much for explaining the operation of vaporizers and carburetors, lubrication, electrical ignition by primary battery, storage battery or magnetos and dynamos. Diagrams are given of customary wiring and other arrangements which the owner is advised to learn, at least for the type of his own boat. Directions are given for starting and operating the motors, with cautions how to avoid troubles and how to meet them. A page is given of typical troubles and their remedies, if the engine refuses to start. There are nine of them, of which six are clearly cases of absent-mindedness and three are accidents that should not occur or should be forestalled. Reverse gears of the planetary type and electric starts are described in some detail.

A chapter is given on power plant installation, that is, of the engine and auxiliaries, and this is the proper complement of chapter five on design, as it is interesting to any owner, enabling him to understand his own power plant and perhaps to correct unfavorable conditions such as a tendency to squat at high speed. Besides the discussion of methods for lining up the engine, mention is made of flexible couplings, stuffing boxes, stern bearings, water pipes and fuel tanks, mufflers and underwater exhaust, and of bailing and pumping devices.

Besides the customary screw propeller, with or without a tunnel, illustrations are given of paddle wheels and air propellers. At the present time an air propeller is more or less of a freak, but the paddle wheel is a practical suggestion for shallow boats in muddy rivers, especially on an amateurish boat. Propeller design is treated in two pages, which is just as well, as an amateur may well buy engine and propeller together and is none too certain of a good job even then. For small boats, reversing propellers are simple and practical, with the advantage that weeds can be shaken off. It is remarkable that freak propellers persist, especially on small boats, though every marine engineer knows that the conventional form and proportions are most efficient and satisfactory. One such is mentioned which has one set of blades ahead of the other.

While the installation of the motor may well be left to the professional, every boat owner should know how to care for his engine and how to make adjustments or to remedy minor defects. In fact, the skipper is likely to find it necessary to make repairs to avoid great discomfort or even danger. This chapter is excellent, being clear and fairly complete. Of course, an amateur may well have personal instruction on the care of his engine, but as he will not get into trouble on purpose even with an instructor at hand, he will find much that is helpful in this chapter.

The final chapter is on flying boats, giving a good introduction to this most recent water craft, or perhaps we should say air and water craft. In the fifty pages given to this matter, only a popular résumé can be expected. Those whose interest is sufficiently excited may find special books on this fascinating sport.

Governing of Prime Movers

REVIEWED BY C. H. PEABODY, DR. ENG.

GOVERNORS AND THE GOVERNING OF PRIME MOVERS. By W. Trinks, M. E. Size, 6 by 8¾ inches. Pages, 236. Illustrations, 139. New York, 1919: D. Van Nostrand Company. Price, $3.50 net.

This is the day of specialists, and the book under review is a book for specialists; in this case for the designers of governors. The author announces that it contains more than he gives his students. Under present conditions it would appear impossible to give any undergraduate class even in an option any large part of the work in the book. The author further promises another work on the dynamics and design of governors for prime movers.

In this book are given the modern investigations of French, German and Swedish engineers, together with the results of the author's personal experience from experiments made in the laboratories of the Carnegie Institute of Technology and in the field, in his efforts to help those who had trouble in regulation.

First the development of modern textile machinery and afterward the introduction of electrical generators called for greater refinement and certainty of regulation than could be had from the old Watt governor. Having one feature of governing in mind at a time, inventors have devised a great variety of governors in the last fifty years. In too many cases an inventor, even if well informed in general engineering, met with disappointment because he failed to provide other necessary properties to his governor than the special features which he might have originated. This may be illustrated by the failure of the isochronous governor, on which much ingenuity was wasted fifty years ago. The Watt governor allowed the engine to slow down slightly when the load increased; the evident remedy was to invent a revolving pendulum with constant height. The effect was that the governor had no stability and would not let the engine run steadily at any speed.

The earliest duty of the Watt governor was to control the throttle valve so that it was but little influenced by the engine except when the valve was nearly closed. But the introduction of the drop cut-off brought in another condition. Early catalogues of builders of these engines advertised that the governor's sole duty was to provide adjustments for releasing the drop mechanism; the engine did the rest. It was soon recognized that a powerful governor was required to hold against the releasing gear, which had the whole power of the engine behind it. The introduction of shaft governors acting directly on the valve gear by adjusting the eccentric or otherwise, together with the influence of the inertia of the parts of such governors that entered either incidentally or intentionally into the design, still further complicated the theory of the governor. All these and many other matters are dealt with by the author, including rate-of-flow and pressure governors; also the special problem of relay governors.

The author begins by pointing out that governors are speed measurers operating on the steam supply or on the valve gear; the relay governor shifts almost all the latter duty to some other source of energy. Attention is given first to centrifugal governors, especially of the Watt type, and of the many modifications of that type. As a motor, the governor must first overcome its own friction which habitually is made small. The author points out the facts (1) that friction is practically eliminated by jarring likely to be imparted to the governor, and (2) that some friction may be desirable in a governor. The author discusses the usual features of the strength of governors and the range of speed, and shows that such discussions are only the beginning of a very important study of governors.

To present the properties of governors, the author used characteristic curves as follows:

(1) Equilibrium speed against position of collar.
(2) The square of that speed against the position of the collar.
(3) Equilibrium speed against the radial displacement of the centrifugal weight.
(4) The square of that speed against the radial displacement.
(5) Centrifugal force against radial displacement of centrifugal weight.

The last method is preferred.

In the chapter on shaft governors (still important, though not so prominent as at one time) the author deals with the centrifugal moment of rotating masses, moment due to inertia of reciprocating parts, moment due to friction of valve gear, moment due to eccentric and strap, and moment of the springs. In this chapter consideration is given to the effect of tangential inertia, which steadies the governor against impressed forces and prevents racing and hunting.

Consideration is given to the natural period of vibration of the governor, which has importance should it concord with an impressed periodic force. For example, trouble occurs if a pendulum governor has a natural vibration with a period near that of the revolution of the engine. This chapter is followed by one on the effects of outside forces on governors, which may be of two sorts: (1) Resistance due to friction, and (2) devices which act cyclically on the governor. These matters being considered separately, the author takes up the very important matter of interaction between governor and engine, in which are discussed such matters as the influence of solid friction purposely applied and tangenial inertia.

The author has a chapter on discarded types of governors, so that people with inventive minds may be prevented from reinventing with the courage of ignorance mechanisms which were relegated to the scrap heap long ago.

Centrifugal pumps and turbo-blowers may give varying flow at constant speed and consequently require governors deriving a force from the flow itself. Examples of such governors are given without the theory. Constant pressure governors for pumping machinery in a similar way derive their force from the pressure; this matter receives a brief discussion. Relay governors are discussed at greater length.

From the author's own experience he gives a chapter on troubles and remedies which is very interesting and informing. In an appendix are given certain mathematical discussions which the author prefers to omit in the text with illustrative examples. There is also a most useful bibliography.

The author avows his desire to limit the size of the book to avoid an excessive cost. This appears unfortunate, since it leads to overconsideration and a dry, not to say arid, style. In fact, the book is hard to read; doubtless the author in the classroom provides the necessary dilution so that his students do not find it too hard. It is hoped that this will not be considered carping criticism of a book that is full of important and unusual information.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Drawing Load Lines on Vessel in Dry Dock

Q. (1113).—Which is the simple and proper way of drawing the light and deep load lines when a ship is in dry dock?

A. (1113).—It is assumed that the draft of the vessel forward and aft for both the light and load condition is known. Then the waterline, either light or load, is the trace formed by the intersection of a plane perpendicular to that of the ship's central longitudinal plane and passing through the light or load draft points at either end of the vessel.

In drawing these lines upon the surface of the vessel the two following methods, or variations thereof, are frequently used:

For large vessels, see Figs. 1 and 2.

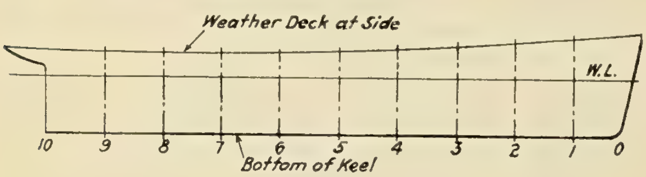

Fig. 1

Lay off the waterline desired, either on the sheer draft plan or on the mold loft floor.

Determine the distance x or y of this line, at the various stations throughout the vessel's length, from a fixed reference line, generally the bottom of keel or the line of weather deck at side.

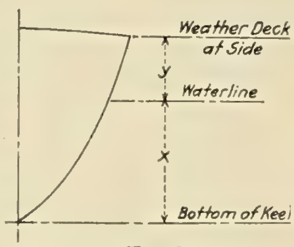

Fig. 2

Locate the stations on the ship itself, and locate on each at a proper distance from the reference line the point through which the desired waterline passes.

When a sufficient number of such points have been located, the required line may be easily drawn through them.

For small vessels, see Fig. 3.

Fix lines *AB* and *CD* at the forward and after perpendiculars respectively, each in a plane perpendicular to the vessel's longitudinal central plane, the first being at the desired draft forward and the second at the desired draft aft.

Between the guides *AB* and *CD* draw xy. If *AB* and *CD* are heavy straight edges rigidly secured in place and xy a chalk line tightly stretched, the latter may be so manipulated as to obtain the required spots on the vessel's hull in a very expeditious manner by moving x and y continuously inboard toward the stem and stern post along the guides.

Sometimes the waterline is to be slightly sheered up forward and aft. When this is to be done the methods above described are modified, in the first case, by laying

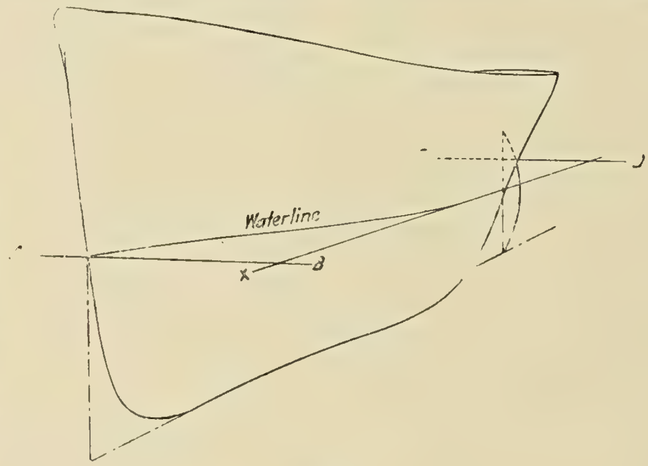

Fig. 3

off the original line on the sheer plan or in the mold loft to the desired curvature and measuring accordingly; in the second case, by permitting a proper amount of slack in the line xy.

Light and Load Draft of a Ship

Q. (1105).—Is there a way of finding out by the classification of ships as given by Lloyd's Register the light and load draft of a ship?

A. (1105).—Lloyd's Register gives the load draft to the center of the Plimsoll mark. It does not, however, give the light draft or any information from which it can be obtained.

From the nature of the information in Lloyd's Register, and from the fact that there exists some confusion, even among men generally familiar with ships, as to the exact meaning of the terms "tonnage" (particularly "gross tonnage"), "deadweight" and "displacement," it is assumed that you have in mind the possibility of using the tonnage figures for the derivation of displacement and deadweight and the obtaining of the light draft therefrom.

The *Shipbuilding Cyclopedia,* published by the Simmons Boardman Publishing Company, New York, gives the following definitions:

> "Displacement is the amount or quantity of water displaced by a floating vessel. It exactly equals the weight of the vessel itself with whatever is on board at the time at which the displacement is recorded.
>
> "Deadweight is the total weight of cargo, fuel, stores and water which a ship can carry when at her designed draft.
>
> "Gross tonnage is the entire internal cubic capacity of a vessel expressed in tons of 100 cubic feet each."

That there can be no relationship between them which is sufficiently definite to be of value in deriving one from the other is evident from the following:

The light draft of a ship is the draft of the ship complete, ready for sea, with full outfit and equipment, but with no deadweight on board.

The load draft is her draft when complete as above, but in addition carrying her full deadweight; that is, cargo, fuel, stores and water. The amount of her deadweight will be that deadweight carried when floating with the water surface at the center of her load line disk as fixed in accordance with "Instructions to Surveyors" by the British Board of Trade.

We may, then, state that the load displacement minus the deadweight equals the light displacement. Now, displacement in salt water, either load or light, in tons =

$$\frac{L \times B \times H \times k}{35},$$

where

L = the length on waterline;
B = the beam on the waterline;
H = the draft, and
k = the block coefficient.

Lloyd's Register gives *L, B, H,* but does not give displacement (either load or light), block coefficient or deadweight, so that while we may obtain the allowed load draft directly from this source, we do not get the light draft nor can we derive it.

The Register gives also the gross, under-deck and net tonnage. If it were possible to establish a relationship between any of these and deadweight and displacement, the light draft would be obtainable by substitution in the above equations.

The determination of tonnage in accordance with the present rules is essentially an attempt to ascertain the volume of the earning spaces of a ship. Briefly, the process consists of finding the total volume of hull to the weather deck, to the inside of ordinary frames and above the top of floors or inner bottom, plus that of enclosures above the weather deck, certain exemptions being allowed for galleys, wheel houses, latrines, etc. The figure thus determined is called gross tonnage.

Deductions from the gross tonnage are then made for spaces occupied by machinery, crew, fuel, navigational instruments, ship stores, etc., and there results a reasonable approximation to the volume of the cargo or earning spaces. This is termed the net tonnage.

Note now that in deriving the gross tonnage the double bottom spaces and those outside of inner face of ordinary frames and floors have been omitted, while the volumes of enclosures above the weather deck have been included.

Note also that two ships of the same dimensions, draft and load displacement, but differing in type and arrangement of decks and superstructures might have radically different values of gross tonnage.

Note again that two ships of the same type, dimensions and draft, but of differing degrees of fineness of underbody and therefore of different displacements, could readily be designed to obtain practically the same value of gross tonnage.

These are but instances of the possible variations in ship design and arrangement which make the establishment of a definite or even approximate relationship between gross tonnage and displacement impracticable.

In a similar manner the possibility of using the net tonnage is eliminated, because on account of its derivation from the gross tonnage it is subject to all the elements of uncertainty already described and in addition to those introduced by the several deductions allowed.

For example, two ships of the same dimensions, displacement and gross tonnage might easily have such widely varying deductions for machinery space as to give very different values of net tonnage. Or one might be designed for a long and the other for a short voyage, and the fuel space deductions be radically different.

Taking up now the subject of deadweight, the amount of which must be known in order to pass from the load to the light displacement, it is evident that neither the value of the gross nor of the net tonnage will be of assistance, as these are essentially volumetric conceptions, while that of deadweight is independent of volume.

Calculation of Bottom and Boot Topping Area of Ship

Q. (1114).—What method is used for calculating the bottom and boot topping area of a ship, both when afloat and when in dry dock?

A. (1114).—From the wording of your question it is assumed that you have in mind a method of estimating and not the actual measuring of areas from the ship.

In case you have a displacement sheet and lines and body plan:

You may measure to scale the perimeter of the waterline at the mean height of the boot topping and multiply the result by the mean width of the boot topping in order to obtain the boot topping area.

In order to obtain the bottom area (assumed waterline) in case no curve of wetted surface is given on the displacement sheet, you may use Admiral Taylor's formula:

$$\text{Wetted surface} = C\sqrt{\Delta \times L}.$$

In this formula Δ = the displacement in tons to the waterline in question, L = the length of the ship in feet on the waterline, and C a constant depending upon the ratio of beam to draft. Its value may be obtained from the following table, in which B and H are beam and mean draft respectively:

$B \div H$	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	$B \div H$
C	15.63	15.58	15.54	15.51	15.51	15.50	15.51	15.53	C
$B \div H$	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	$B \div H$
C	15.55	15.58	15.62	15.66	15.71	15.77	15.83	15.89	C

By means of this formula solved for values of displacement corresponding to drafts taken to the upper and lower limits of the boot topping, two values of wetted surface may be obtained. The difference between them will be the area of the boot topping. This method will serve as a check on that suggested above.

In case neither a displacement sheet nor lines are available, you can doubtless obtain a displacement draft scale which will enable you to use the methods just described. These methods, you will note, are independent of the vessel's position, whether afloat or in dry dock.

Gaskets and Packing

Q. (1,052).—What type of packing is best for the plungers of fuel oil pumps of the usual type, i. e., duplex pumps with inside packed plungers?

What style of packing is best for the stuffing boxes of the piston rods of the fuel oil pump? We have been using ordinary spiral steam piston rod packing.

Kindly give formula for a white paint which will stay white under the heat of the cylinders of the main engine, etc. K. W. W.

A. (1052).—The writer has found that an oil pump plunger fitted with bronze piston rings has given very good service. In regard to rod packing, a somewhat similar situation holds, i. e., a metallic packed plunger rod which many pump makers fit to fuel oil pumps will have a very long life under proper conditions. The rod packing you are using should answer very well.

A white lead paint mixed with linseed oil will turn yellow under heat. If zinc white is used and mixed largely with turpentine, it will withstand a fairly high temperature.

PERSONAL MENTION

William A. Dobson, naval architect of Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., is chairman of the committee on classification, appointed by the Atlantic Coast Shipbuilders' Association, which will co-operate with the American Bureau of Shipping.

Lieutenant-Colonel George C. Cook has recently been appointed naval architect of the United States Mail Steamship Company, New York City. Lieutenant-Colonel Cook is a graduate of the first class at Webb Academy, New York City, in 1897, later graduating in naval architecture and marine engineering from Glasgow University, Glasgow, Scotland. At various times between the years 1897 and 1901 he was engaged as a ship draftsman for the Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, and in charge of the design of harbor craft and troop transports for the Howaldts Werke, Kiel, Germany. From 1901 to 1906 he conducted a ship brokerage and naval architect's office in New York City, designing and superintending the construction of various commercial vessels and yachts. During this period he delivered a series of lectures for the Board of Education of New York and acted as an instructor in naval architecture and marine engineering in the New York Nautical College. Until the war broke out in 1917 he was assistant engineer and superintendent of construction of the marine division of the United States Lighthouse service, designing and supervising the construction of vessels for this service at various shipyards. When the Emergency Fleet Corporation was formed, Mr. Cook was released from the Lighthouse Service to become chief technical aide of the corporation, acting as assistant to the chief of the department of general commandeering, appraising values of commandeered vessels in all stages of completion. He was released from this service to enter the army for duty in France, first as a major and later as a lieutenant-colonel. In this connection he was chief vessel repair officer of the American Expeditionary Forces, organizing and operating large vessel repair units, including the personnel and shops at St. Nazaire, Bordeaux, smaller units at Marseilles, La Pallice, Le Havre and Brest. For his work with the army he was awarded a citation by General Pershing "for exceptional meritorious and conspicuous service." Following his release from active duty in October, 1919, until recently he was an inspector in the construction and repair department of the United States Shipping Board, engaged in preparing specifications and plans for the reconstruction of ex-German passenger vessels, surveying and reporting all classes of damage, estimating cost of repairs and valuations, supervising repair work, handling bids for work and performing the miscellaneous duties of a general inspector. Lieutenant-Colonel Cook is a member of the Institution of Naval Architects, London, England, of the Royal Societies Club, London, England, a former member of the American Society of Naval Architects and Marine Engineers, of the Congress d' Architecture et de Construction Navales, and of the Union de Langues Francaise, Paris, France.

Lieut.-Col. George C. Cook

N. Karfve, former assistant general manager of the Pusey & Jones Company plant, Wilmington, Del., has left the service of this company for an extended trip through Europe.

Paul J. Keifer, formerly assistant professor of steam engineering, University of Illinois, is now associate professor of mechanical and marine engineering, post-graduate department, United States Naval Academy, Annapolis, Md.

Howard G. Cosgrove, of Seattle, has resigned from the position of counsel for the Emergency Fleet Corporation for the states of Washington and Oregon.

Erskine Wood, of Portland, Ore., has been appointed Admiralty Counsel of the United States Shipping Board to succeed Charles F. Dutch, of Boston.

J. Harry Philbin, of Baltimore, Md., has been promoted from acting sales manager to manager of the ship sales division of the United States Shipping Board.

William Gatewood, naval architect, Newport News Shipbuilding and Dry Dock Company, is chairman of the Atlantic Coast Shipbuilders' Association committee on standard forms of contract for new construction and repair work.

Captain Frank E. Ferris, special commissioner for the Shipping Board in London, is in charge of all European offices of the Shipping Board, and according to a recent statement of Admiral Benson, is creating an efficient organization abroad. Captain Ferris formerly was with the Export Steamship Company, New York.

R. A. Dean, formerly general counsel of the United States Shipping Board, has been appointed assistant to the chairman of the Shipping Board.

R. A. Dean

Robert M. Gates has been appointed managing engineer in charge of the Philadelphia, Pa., district of the Lakewood Engineering Company, Cleveland, Ohio, with offices at 1034 Widener building, Philadelphia. Mr. Gates is a graduate of Purdue University. He has been active in organizing the material handling section of the American Society of Mechanical Engineers and is acting as chairman of that section during its period of organization. He has devoted the past twelve years to the design and engineering surveys of mechanical means of conserving labor in the construction, industrial and transportation fields.

Henry Newkirk Winner, formerly manager of the Philadelphia branch of the Garlock Packing Company, has been placed in full charge of the packing department of the United States Rubber Company, 1790 Broadway, New York.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

AMERICAN YARDS DELIVERED 34 VESSELS IN SEPTEMBER

Shipping Board Received An Aggregate of 246,225 Tons Including 30 Large Steel Steamers—Launchings Showed a Decline

American shipyards delivered thirty-four new vessels, of which thirty were large steel steamers, to the Shipping Board during September. They aggregated 246,225 deadweight. Two concrete tankers—the Palo Alto, built by the San Francisco Shipbuilding Company, and the Cuyamaca, built by the Pacific Marine and Construction Company, both of 7,500 deadweight tons—were delivered for operation. The largest vessel on the list, the Trinity, a steel tanker of 11,375 deadweight tons, was built by the Newport News Shipbuilding and Dry Dock Company and was one of seven tankers turned over during the month.

Another American shipyard completed its contracts for the board. The Union Construction Company delivered the 9,400 ton freighter Heber on the last day of the month. The California shipyard built ten freighters of this type for the Emergency Fleet Corporation. The Usaga Dock Company, one of the Japanese shipyards which aided the government in its creation of a merchant marine, wound up its work with the completion of the 5,500 deadweight ton freighter Eastern Sword. The company built four steamers of this type.

While the deliveries exceeded 200,000 tons, the launchings dropped considerably. Only nine ocean-going steamers of an aggregate deadweight register of 78,830 tons were put afloat. The largest was the 13,000 ton combination freight and passenger liner Wolverine State, which is being produced by the New York Shipbuilding Company at its Camden yards.

Following are the ships launched and delivered:

LAUNCHED

Name and Builder	D.W.T.
Lake Gano, Saginaw S. B. Co.	4,080
Yalza, Merchant (Bristol) S. B. Corp.	9,000
Wm. Penn, Pusey & Jones Co.	12,500
Wolverine State, N. Y. Shipbuilding	13,000
Syros, Geo. A. Fuller Co.	9,600
West Honaker, Los Angeles S. B. & D. D. Co.	8,800
Moffet (concrete tanker), A. Bentley & Sons Co.	7,500
Memnon, Hanlon D. D. & S. B. Co.	5,350
Geo. E. Weed, Merchant (Bristol) S. B. Corp.	9,000

DELIVERED

Name and Builder	D.W.T.
Carplaka, Hog Island	7,500
Carabrille, Hog Island	7,500
City of Fort Worth, George A. Fuller Co.	9,600
Half Moon, Newburgh Shipyards Corp.	9,000
Trinity (tanker), Newport News S. B. & D. D. Co.	11,375
Yaka, Merchant (Bristol) S. B. Corp.	9,000
City of Freedom (tanker), Baltimore D. D. & S. B. Co.	6,000
City of Lordsburgh, Mobile S. B. Co.	5,000
Tomalva, Hog Island	7,500
City of Weatherford, Pensacola S. B. Co.	9,000
Castana, Hog Island	7,500
Derblay, Hanlon D. D. & S. B. Co.	5,350
Cody, Hog Island	7,500
Palo Alto (tanker), San Francisco S. B. Co.	7,500
Pachet, Atlantic Corporation	6,800
Cuyamaca (tanker), Pacific Marine & Const. Co.	7,500
Catahoula, Hog Island	7,500
Manatawny, Hog Island	7,500
Gateway City, Merchant (Bristol) S. B. Corp.	9,000
Bidwell (tanker), Baltimore D. D. & S. B. Co.	10,300
Stockton (tanker), Moore S. B. Co.	10,000
West Canon, Western Pipe & Steel Co.	8,800
Hybert, George A. Fuller Co.	9,000
Glenora, Bethlehem (Harlan) S. B. Co.	7,400
Halway (tanker), Bethlehem (Alameda) S. B. Co.	10,100
Hastings, Pensacola S. B. Co.	9,000
Lavada, Pacific Coast S. B. Co.	9,400
Provincetown, Groton Iron Works	9,400
Heber, Union Construction Co.	9,400

Oriental Navigation Buys Another Coal Mine

The Oriental Navigation Company has purchased the property of the Orinoco Mining Company, of Orinoco, Ky. This property represents some of the best veins of steam coal in West Indiana and Kentucky, and gives the navigation company coal holdings aggregating approximately 2,000 acres, with an estimated 10,000,000 tons of coal unmined. The average production of the mines of this company, together with the William-Pocahontas mines at War, W. Va., recently purchased, is now 7,500 tons per day.

Tanker Orders on Pacific Coast

The Standard Oil Company of California has placed a contract for three 15,000-ton deadweight tankers with the Union (San Francisco) plant of the Bethlehem Shipbuilding Corporation, Ltd.

Work is to be started on the oil carriers immediately, and it is anticipated that the first vessel will be delivered in May or June of 1921. The other two will be delivered during the summer months.

This is the largest single order for tank steamers placed by an American company within the past few weeks.

FOUR NEW MEN NAMED

Benson Remains as Chairman of Shipping Board

Five of the seven members of the new Shipping Board were appointed on October 21 by President Wilson.

Admiral William S. Benson, chief of naval operations during the war, was reappointed chairman. The other four members named were: Frederick I. Thompson, a newspaper publisher of Mobile, Ala.; Gavin McNab, an attorney of San Francisco; Martin J. Gillen, an attorney of Wisconsin, and Theodore Marburg, a publicist of Baltimore.

Mr. McNab and Mr. Marburg both declined to serve.

The members of the new board are to receive salaries of $12,000 a year and under the law they must divest themselves of all shipping interests and devote all of their time to their work as shipping commissioners.

Two of the seven members must be named from the Atlantic Coast, two from the Pacific Coast, one from the Gulf region, one from the Lake region and one from the interior. This leaves one appointee from the Pacific Coast and one from the interior still to be named.

The appointments aroused no enthusiasm in New York shipping circles.

NEW OPERATING TERMS

Shipping Board Agreement Retroactive to March 1

With the statement by Admiral Benson that the Shipping Board intends that there shall be no further changes in the arrangements between the Board and ship operators, the new agency terms have been announced officially.

Carrying the provision that the agreement is retroactive to March 1 last, the new contract provides for compensation at the rate of 5 percent on gross outward freight, dead freight demurrage, express and mail revenue, but only 2½ percent on full cargoes of grain, coal, sulphur and phosphate; 2½ percent only is to be paid on full cargoes of other commodities sent from one shipper to one consignee; 2½ percent is to be paid on gross inward freight, dead freight demurrage, express and mail revenue, with a minimum fee of $250 at each port where cargo is discharged. These provisions apply coastwise between United States ports, except in the New England coal trade, where the agent is to receive only 2½ percent on outward freight and nothing on inward.

Between ports other than the United States 2½ percent is allowed on gross outward freight and the same on inward. Five dollars a day with a minimum of $50 is allowed on ballast voyages.

The contract allows $25 a day beyond ten days for vessels under repair. Ten percent is allowed on gross passenger and excess baggage revenues, with the exception that 5 percent only shall be paid on gross passenger and excess baggabe revenues on cargo vessels.

The contract also provides for the payment of commissions on freight, passenger and carrier brokerage where these are properly incurred in accordance with the usages of the trade.

Shipping Board to Make Repairs

The Shipping Board announces that in the future it plans to make all incoming voyage repairs to vessels and such other repairs as may be necessary to retain class. This policy will revise the "as is" clause in future sales of new steel vessels, but does not apply to the sale of vessels which are in need of such extensive repairs that the board would not be justified in assuming the cost.

Maine Steamer Lines May Be Sold

Elwell S. Crosby, of Bath, Me., heads a group of business men of that city who have obtained an option from the Eastern Steamship Company on two of its steamship lines—from Boston to Bath, and from Bath to Boothbay. The Boston-Kennebec service has been discontinued for some time.

The property to be disposed of includes the steamers *City of Rockland* and *City of Bangor* for the Boston and Kennebec line; and the *Wiwurna* and *Catherine* for the Boothbay Harbor division. In addition to the steamers are wharf properties, rights and privileges at Augusta, Hallowell, Gardiner, South Gardiner, Richmond, Dresden and Bath, these being the regular landing places of the Boston and Kennebec steamers in the past. The Boston end of the line would be secured by the rental of wharf privileges, which is also covered in an agreement.

Other wharf properties, rights and privileges covered by the option are at Southport, Westport, Westport Junction, Sawyer's Island and Boothbay Harbor.

Merger for Waterways

A merger of the Mississippi Valley Waterways Association with the Mississippi Valley Association was effected at a meeting of the directors of these two organizations in St. Louis on October 2. Under the terms of the merger, James E. Smith, president of the Mississippi Valley Waterways Association, will become head of the newly created Waterways Division of the Valley Association.

FAMOUS NAME RETAINED

Great Lakes Engineering Works Stronger Than Ever

It is regarded as significant to the shipbuilding industry that the reorganization of the Great Lakes Engineering Works has been completed, and the concern "will continue, as heretofore, the business of designing, building and repairing ships." An interesting fact in this connection is that the employees of the company, on their own initiative, have subscribed for over one-third of the entire capital stock of the company, which was transferred to them at the cost price paid for the properties and immediately paid for. This is a unique event in the history of the shipbuilding industry of the world.

Antonio C. Pessano, for many years an outstanding figure in American shipbuilding, possessed of a host of personal friends, and admired for his executive ability and foresight, is the head of the new undertaking, as he was of the old. He is a vice-president of the American Bureau of Shipping and a life member of the Society of Naval Architects and Marine Engineers, besides holding other important maritime connections.

At a stockholders' meeting at the River Rouge shipyard the old corporate name "Great Lakes Engineering Works" was readopted, and six directors were chosen, making the full directorate as follows: Antonio C. Pessano, John A. Ubsdell, George B. Turnbull, Frederick G. Morley, C. Henry Hecker, T. W. Palmer Livingstone and Joseph Boyer, Jr., all of Detroit, Mich.; Isaac W. Frank, of Pittsburgh, Pa., and John T. Webster, of Cleveland, Ohio.

The directors have elected these executive officers: Antonio S. Pessano, chairman of the board; John A. Ubsdell, president and general manager; George B. Turnbull, vice-president and assistant general manager; John T. Webster, vice-president; Frederick G. Morley, secretary and treasurer.

The following appointments have been made: Charles E. Baisley, manager, River Rouge shipyard; Frank C. Pahlow, manager Ashtabula shipyard; Robert Jackson, manager, Detroit Engine Works; Charles Short, secretary to the president.

Five Piers Taken From Shipping Board

An executive order by President Wilson, under the new Merchant Marine Act, exempts Piers 1, 4, 5, 6 and 11, and others, formerly owned by the North German Lloyd and Hamburg-American steamship companies, and the Hoboken Shore Railroad, from the control of the Shipping Board, which was, on January 1 next, to take control of all government docks, warehouses, and other marine transportation facilities not exempted by the President. The piers numbered have been leased by the War Department to the Panama Steamship Lines.

This order caused considerable surprise in New York shipping circles, as preparations were under way by local representatives of the Board to use the docks after January 1 for several lines of government owned or controlled vessels which are now hampered by crowded dock conditions. One of these lines is now using a Hoboken terminal in its South American service.

SEATTLE YARDS PROFITED

Alterations to Japanese-built Vessels Kept Them Busy

When the repairing and alteration of Japanese-built steamers on Shipping Board account at Seattle is completed, which will be when the *Eastern Sword* is delivered to the Board, more than $1,720,000 will have been spent in Seattle yards, in sums ranging from $34,134 to $135,220.

Yards handling the work comprise the Todd Dry Docks, Inc., the Skinner & Eddy Shipbuilding Company, J. F. Duthie & Co., and the Pacific Coast Engineering Company. By yards, the ships and contract prices follow:

Todd Yard—*Eastern Guide,* $71,000; *Eastern Gale,* $65,866; *Eastern Victor,* $67,000; *Eastern Admiral,* $51,500; *Eastern Tempest,* $48,605; *Eastern Importer,* $110,381.

Pacific Coast Yard—*Eastern Moon,* $34,134; *Eastern Marine,* $61,590; *Eastern Pilot,* $45,000; *Eastern Glade,* $72,500; *Eastern Cloud,* $67,225; *Eastern Maid,* $47,500; *Eastern Sailor,* $138,220; *Eastern Soldier,* $82,500; *Eastern Temple,* $62,100; *Eastern Leader,* $85,500.

Skinner & Eddy—*Eastern Knight,* $81,881; *Eastern Crag,* $53,980; *Eastern Ocean,* $67,499; *Eastern Planet,* $54,400.

Duthie Yard—*Eastern Crown,* $65,450; *Eastern Dawn,* $51,498; *Eastern Glen,* $59,150; *Eastern Exporter,* $101,996.

BALTIMORE YARDS BUSY

Tankers Orders Aggregating 190,000 Tons in Sight

Construction of bulk and ore carriers is providing a good quantity of present work and rosy prospects for the future in the big shipyards of Baltimore, and officials of the Baltimore Dry Docks & Shipbuilding Company explain this as being the result of the increasing use of oil as fuel for ships, and Baltimore, with increasing commercial and marine facilities, is expecting soon to rival the world's largest shipbuilding ports in the construction of oil and ore carrying ships.

The Dry Docks Company has six tankers under construction; the Bethlehem Shipbuilding Corporation has started work on a series of ships of 20,000 tons each, built to carry either oil or ore; the Union Shipbuilding Company is building ore carriers for the Aluminum Company of America, and the Globe Shipbuilding Company, which has been operating since June 1, is at work on two tankers of 8,600 deadweight tons each.

U. S. YARDS LEAD IN TANKER TONNAGE AND VESSEL SIZE

Construction 1097 Percent Over Pre-War Figures, But Not Keeping Up With British Yards in Total Production

American shipyards to-day are further behind the British yards in the total amount of tonnage under construction than they were before the war, says a statement issued by Lloyd's Register of Shipping. This does not mean that American shipbuilding is returning to the small position it held in the world's output of tonnage in pre-war times, but it indicates how sharp the decline has been from the maximum production figure attained by this country during the war.

Even on the present reduced scale of output, however, the tonnage building in American yards represents an increase of 1097 percent over the total being constructed just prior to the war, while the British gain in the same period has been only 116 percent.

The great advance of American shipbuilding over the pre-war status of the industry, the subsequent sharp decline, and the course of British shipbuilding, may be shown by the following figures giving in gross tons the totals under construction for the two countries at the dates named. The peak of the American output was reached in the quarter ending March 31, 1919:

	June 30, 1914	March 31, 1919	Sept. 30, 1920
British	1,722,000	2,255,000	3,731,000
American ..	148,000	4,186,000	1,722,000
	*1,574,000	†1,931,000	*1,959,000

* British lead. † American lead.

Compared with the pre-war figures, American shipyards are now building 1,623,000 gross tons more and British yards, 2,000,000 tons. At the maximum of the American effort, however, the gain over the 1914 figure was in excess of 4,000,000 tons, so that the present figure marks a decline of nearly two and a half million tons.

Returns made by Lloyd's Register for the quarter ended September 30, however, indicate that in some respects American shipyards still lead the world. The chief demand at present is for tanker tonnage and in this type of construction the United States is building more than double Great Britain and all the rest of the world put together, as the following table shows:

	Number	Gross Tons
United States........	79	545,302
United Kingdom......	32	232,758
Other countries......	3	18,000
World total........	114	796,060

Another point in which this country leads is in the average size of the vessels under construction. Taking steel steamers, Lloyd's Register returns show that while Great Britain is building 912, aggregating 3,715,000 gross tons and the United States only 280, totaling 1,735,000 tons, the average size of the British steamers is only 4,074 tons, as against 6,197 tons for the American vessels. Of the 921 steamers building in the United Kingdom, 551 are of less than 4,000 gross tons each. Great Britain, however, is building a number of large ships, 25 of those under construction being of 15,000 tons and upwards, and 64 of 10,000 tons and above.

American construction is now being practically entirely devoted to steel steamers, Lloyd's Register returns show for the various districts of the United States, the figures representing gross tons:

	All Types	Steel Steamers
Atlantic Coast....	1,241,000	1,229,000
Pacific Coast.....	342,000	331,000
Gulf Coast.......	155,000	141,000
Great Lakes......	34,000	34,000
Total	1,772,000	1,735,000

Wooden steamers under way represent only 18,000 tons of the American total, compared with 1,169,000 tons two years ago and 211,000 tons one year ago. About the only country paying any attention to this type of vessel to-day is Italy, where 47, aggregating 20,000 tons, are under way.

Classification Rates Up

Lloyd's Register of Shipping and the British Corporation have increased their charges for classifying ships, and the American Bureau of Shipping has appointed a committee to consider the advisability of following the lead of the other two societies. It is reported that the charges are nearly doubled under the new scale.

The cost of the service rendered by the classification society is relatively a very small item in the total value of a ship. Roughly speaking, the societies charge about $2,800 for classifying and surveying a 10,000 deadweight ton freighter. The fee of 25 cents a ton is exacted for inspecting the materials entering into the ship.

Permanent Marine Exposition Planned

Chas. Cory & Son, Inc., of 183-187 Varick Street, New York, are planning to establish, in a section especially constructed for the purpose, a permanent marine exposition for the display of ships' electrical and mechanical telegraph systems, lighting equipments, instantaneous-reading shaft revolution indicators, engine direction indicators and revolution counters, watertight marine loud speaking anti-noise telephones, the anticipating and emergency marine governors, control systems for floating dry docks, fire alarm systems, and all other signalling and communicating systems required for naval or merchant ships.

BUSINESS NOTES

The Morris Machine Works, Baldwinsville, N. Y., has opened a new office at 1630 Real Estate Trust Building, Philadelphia, Pa.

Raymond E. Lovekin, advertising engineer, is now occupying new quarters in the Fuller Building, 10 South 18th Street, Philadelphia.

Col. George C. Cook, naval architect for the United States Mail Steamship Company, 45 Broadway, New York, is in the market for catalogues, literature, samples, etc., for the work of his office in connection with the reconditioning of several of the large ex-German liners which have been taken over by his company.

The Lancaster Steel Products Corporation, of Lancaster, Pa., has opened a New York office in the National Association Building, at 25 West 43d Street, in charge of Mr. L. E. Vesey, as district sales manager. Mr. Vesey comes to New York from the Chicago office. This office, together with the Hartford, Conn., Detroit and Chicago offices, will enable the corporation to more adequately take care of its rapidly growing business in the cold rolled and cold drawn field.

The continuing activity and prosperity of the electrical industry is shown by the volume of business reported by the Western Electric Company, 195 Broadway, New York, whose sales for eight months of the current year in domestic billings showed a total of $119,500,000, indicating sales for the year of approximately $190,000,000, not including export business nor sales of its foreign affilated companies. The export and foreign business will probably reach $38,000,000, bringing the total business up to more than $225,000,000 for the year.

Seabury & de Zafra, Inc., consulting naval architects and marine engineers, 150 Nassau Street, New York, have enlarged their offices in order to better accommodate their business, which has been developing rapidly during the past few months. Contrary to a prevailing impression, Mr. Charles L. Seabury has no connection with the shipyard which formerly bore his name. Murray S. Webber, formerly with the Merchant Shipbuilding Corporation, Chester, Pa., has joined Seabury & de Zafra.

The Diamond Power Specialty Company, Detroit, Mich., has available for distribution a special stereopticon lecture entitled, "Increasing Marine Profits," prepared by Robert June. The lecture is devoted to the possibilities of increased boiler efficiency, and deals with various phases of marine operation, in particular the construction and function of the various types of Diamond Soot Blowers being described. The lecture is available to marine engineers, shipping and ship building concerns, and college and naval authorities, on application to the home office of the company at Detroit.

TRADE PUBLICATIONS

Steam Hoists.—The Lidgerwood Manufacturing Company, 96 Liberty street, New York City, has issued a catalogue describing steam-hoisting engines for contractors' uses. Specifications and details of construction are given for engines to be used for derricks, pile drivers, coal hoisting, dredge work and the like.

Reading Wrought Iron Pipes.—This new catalogue of the Reading Iron Company, Reading, Pa., contains a brief history of the iron industry from the time the metal was first discovered down to the present. In addition to this, a complete description accompanied by illustrations is given of the modern processes as carried out by the Reading Iron Company.

Plymouth Rope and Cordage.—The general catalogue issued by the Plymouth Cordage Company brings together in convenient form for reference such information as will make clear to buyers the distinguishing characteristics of the different kinds of Plymouth cordage, and will enable them to secure the kinds best adapted to their various needs.

American Ingot Iron Wire.—The Page Steel & Wire Company, 30 Church Street, New York, has recently issued a pamphlet which presents in convenient form data and tables pertaining to the properties of American Ingot Iron Wire. This information is of interest to engineers, superintendents, and purchasing agents, and to the wire industry in gentral.

Data Book for Engineers.—The Locomotive Superheater Company, 30 Church street, New York City, has issued a convenient pocket size data book for the use of practical operating engineers. The uses of superheated steam in boilers is discussed in the introductory pages and the remainder contains tables and general information useful in the operation of a power plant.

Industrial Uses of Superheated Steam.—This is a reprinted pamphlet by the Power Specialty Company, 111 Broadway, New York. The original paper was read before the American Society of Heating and Ventilating Engineers. The various uses of superheated steam are stated and illustrated, and there are also a number of calculations of heat transfer and steam saving accomplished by it.

Defend Your Steam.—Under this title the Magnesia Association of America has issued a booklet discussing the problems of pipe and boiler insulation. The aim of this book is to furnish the key to some of the problems confronting the architect, engineer and owner in the conservation of fuel by the provision of adequate protection for the steam pipes, valves, boilers, and other heated surfaces against heat losses.

Feed Water Heating.—A pamphlet recently sent out by the Griscom-Russell Company, 90 West Street, New York, reviews the advantages of feed water heating and gives a general description of the device known as the Reilly Water Heater, produced by this company. Complete specifications for various types and sizes of the heater are given, together with instructions for determining the proper equipment for any given boiler installation.

Synchronous Condensers.—A bulletin superseding all previous data from the General Electric Company, Schenectady, N. Y., on the subject of synchronous condensers has been issued quite recently. The data contained covers the subject both of power-factor correction and power-factor control, through synchronous condensers. Calculations for the use of the condensers in each connection are given, with several calculations for correction and control.

Locomotive Shops.—Dwight P. Robinson & Company, New York, consolidated with Westinghouse, Church, Kerr & Company, has issued a folder containing thirteen photographs of the Baltimore & Ohio locomotive shops at Glenwood, Pa., and Cumberland, Md., built by Westinghouse, Church, Kerr & Company.

Marine Efficiency Devices.—Among the new devices of the McNab Company, Bridgeport, Conn., combustion indicators, frigidometers, salt detectors, stern tube appliances and torsion meters are described in a catalogue sent out by this company. Complete instructions and calculations when necessary adequately to illustrate the use of the various appliances are given in detail, as well as illustrations and explanations in connection with the devices.

The Story of Gasoline.—In a 40-page pamphlet issued by the Atlantic Refining Company, Philadelphia, many useful and interesting facts concerning the properties of gasoline have been presented in an attractive manner. A chapter on carburization discusses the effect on efficiency and power brought about by variations in the gas mixture. Six pages at the end of the booklet are devoted to a classified list of engine troubles with the remedies.

Prudential Steel Building.—The Blaw-Knox Company, Pittsburgh, Pa., has issued a 32-page catalogue illustrating and describing the line of portable steel buildings manufactured by that company. There are photographs and short accounts of the use of these buildings for a number of different purposes, including labor camps, field offices, watchmen's shanties, industrial buildings, etc. The catalogue also has general plans for various standard structures.

Capstans.—The uses for capstans on board ship are numerous, and the American Engineering Company, Philadelphia, Pa., goes into details on this subject in a catalogue recently issued. Descriptions of steam-driven capstans and gypsey heads, dock capstans, and electric- and hand-driven machines are given in addition to the standard types illustrated. The company announces that special types will be built to any required specifications.

Uehling Instrument Company, 71 Broadway, New York City, exhibited fuel saving devices at two of the leading expositions of the year—the Chemical Show, Grand Central Palace, New York, September 20-25, and the National Association of Stationary Engineers' Convention, Milwaukee, Wis., September 13-17. The principal devices displayed were the new style "U" CO_2 recording equipment, together with Uehling pyrometers and draft gages.

NEW INCORPORATIONS

The following incorporations of maritime interest have been reported in the last month:

American Shipping Agency, Inc., Wilmington, to own and operate boats, $100,000.

American Transatlantic Lloyd, Inc., Wilmington, to own and operate boats, $7,000,000.

Adam Steamship & Commerce Corp., Jersey City, $50,000; H. J. Skinner, Alfred F. McCabe.

Ocean Pearl Products Corp., Manhattan, $50,000; F. Herbek, F. R. Fischer, J. Vrana, Astoria.

Emerald Motorship Co., Delaware, $3,000,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Jamaica Bay Dock Corp., Manhattan, $98,000; R. L. and R. H. Baldwin, J. H. Ward, Ridgewood.

Wallington, Gibson Co., shipping, $50,000; Martin E. Smith, Artemas Smith, A. E. Wallace, Wilmington.

The Calvert Navigation Co., Wilmington—To own and operate boats; incorporators not named, $1,000,000.

Vincent J. Ajello, Manhattan, ship broker, $10,000; A. H. Strickland, J. Potts, V. J. Ajello, 15 William street.

Disappearing Propeller Boat Corp. of New York, Buffalo, $600,000; W. L. Marcy, L. R. Gulick, W. V. Moot, Buffalo.

Baltimore-New York Ship Service Corp., 77 River street, Hoboken—Build ships, vessels, engines, etc., capital, $500,000.

Black Star Steamship Co., Jersey City, $500,000; Samuel B. Howard, Robert K. Thistle, A. Roy Myers, New York.

Dominican Steamship Co., Delaware, $300,000; August E. M. Thiery, Raymond E. Cook, John F. Wharton, New York.

American Commerce Freighting Corp., Wilmington, to conduct a general shipping and lighterage business, $100,000.

Aetna Steamship Corp., Manhattan, $100,000; F. E. Rowland, C. Muller, E. J. Atkinson, 1242 Herkimer St., Brooklyn.

Maurice River Packing Co., Camden, N. J., engage in fishing. $300,000: Edward Burke, Marcus Shop, Matthew Jack, Camden.

Frank J. Alexander, Manhattan, trucking and stevedore, $10,000; F. J. Alexander, F. D. Lewis, J. Dietsch, 459 11th avenue.

Overseas Despatch, Manhattan, steamship and railroad tickets, $10,000; C. F. Spamer, D. Somogvii, J. A. Berko, 140 East 85th St.

De Parrie Co., Manhattan, ship, hotel and club supplies, $7,500; W. Irvine, J. H. Strange, O. J. De Parrie, 166 13th Avenue.

Savannah Coal Dock Company, Delaware, $600,000; Samuel B. Howard, Raymond J. Gorman and Robert K. Thistle, New York.

Wright Engineering and Construction Co., Wilmington, Del., $500,000, dock construction, highway location and construction work.

National Ship Supply and Machinery Co., Manhattan, build vessels, $50,000; Charles Sheer, Elizabeth A. Ikam, L. Algase, New York.

Merchant Marine Corp., Newark, $125,000, to build steamships; J. F. Hefernan, B. F. Hefernan, Elizabeth; G. H. Schwartz, New York.

American Transportation Service, Manhattan, stevedoring, $50,000; T. V. Malley, J. Skelling, J. R. Gatchell, 104 88th street, Brooklyn.

American Transportation and Trading Corp., Delaware, $20,000,000; steamships, &c., T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Immigrant Transportation Bureau, Manhattan, steamship tickets, $10,000; L. Unterman, J. Yedin, L. Schiff, 836 Bushwick avenue, Brooklyn.

Mt. Washington Steamship Co., Wilmington, operate boats, etc., $500,000; George E. Bengle, Robert E. Ammin, Frank M. Gervodette, New York.

Overseas Despatch, Manhattan, steamship and railroads tickets and forwarding, $10,000; J. A. Berko, D. Somogyl, C. F. Spamer, 30 Walcott street, Brooklyn.

Tacony Riverton Ferry Co., Riverton, N. J., operate ferry between Burlington County and Philadelphia, $250,000; Casper M. Titus, Tacony; George T. Sale, C. Warren Allen, Frankford.

Designations

General American Line, Del., 5,000 shares preferred stock, $100 each; 20,000 Class A, common, $100 each; 15,000 common, Class B, no par value; rep., E. S. Napolis, 60 Wall St.

Ovens Tow Boat, Del., $1,000,000; rep., G. W. Ovens, 32 Broadway, New York.

A. Bagadin & Co., Del., steamships, 10,000 shares common stock, no par value; rep., S. B. Howard, 65 Cedar St.

Capital Increases

Todd Shipyards Corp., Manhattan, carry on business with $160,000 and 232 shares common stock, no par value.

American & Cuban Steamship Line, Manhattan, $25,000 to $1,500,000.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Barges, New Orleans, La.—Four 615-ton barges and six 750-ton barges will be built by the Doullutt & Williams Shipbuilding Company.

Tankers, Oakland, Cal.—It is reported that the Hanlon Dry Docks & Shipbuilding Company is negotiating for a contract for the production of several tankers.

Barges, Nashville, Tenn.—United States District Engineer has let contract for building 4 steel barges to Charles Ward Engineering Works, Charleston, W. Va., for $66,000.

Barges, Beaumont, Tex.—Three barges for the Mexican oil trade will be built by T. H. Trahey, of Seattle, at the yards of McBride & Law, Beaumont, Tex., which he recently leased.

Motorships, Seattle, Wash.—It is reported that W. L. Comyn, controlling owner of the Pacific Motorship Company, is negotiating for the purchase of four motorships from the J. E. Chilberg Company.

Tankers, Ottawa, Canada.—The new Government of Mexico has placed an order with the Prince Rupert Dry Dock Company of Ottawa, Can., for the construction of thirty-seven ships, mostly oil tankers.

Barges, Mobile, Ala.—The Henderson Shipbuilding Company, is building a 400-ton barge for its own account, and will soon begin building three more. The plant also has extensive repair contracts on hand.

Repairing Vessels, Seattle, Wash.—Five deep sea vessels, and two Puget Sound carriers are lined up at the Harbor Island Plant of the Todd Drydocks, Inc., for repairs aggregating an expenditure of $100,000.

Rebuilding Steamers, Seattle, Wash.—The Pacific Coast Engineering Company has secured the contract for converting the Japanese-built steamship Eastern Leader from a coal burner to an oil burner at a cost of $82,500.

Barges, Bath, Me—The Kelley, Spear Company, Bath, Me., has recently obtained contracts for building two ocean coal barges of 3,000 tons deadweight capacity each, for the Staples Transportation Company, Fall River, Mass.

Steamers Bought, New York.—The Green Star Steamship Corporation, 115 Broadway, has purchased four 9,550-ton vessels from the G. M. Standifer Construction Corporation, Seattle, Wash., for about $165 per deadweight ton.

To Build Steamer, San Francisco, Cal.—J. D. Spreckels, president of the Oceanic Steamship Company, San Francisco, has stated his company plans to build a steamer for the Australian-San Francisco passenger service to replace the steamer Sierra.

Freighter, South Portland, Me.—Work is going ahead on the 1,200-ton freight steamer building in the yard of the P. H. Doyen Company, she being now partly planked in. She is being built for sale, and the builders expect to put her overboard early next spring.

Tankers, Wilmington, N. C.—A report that the Carolina Shipyard is building four freighters for builder's account was an error. The company is building two tankers for its own account, and two for the Eagle Oil Transport Co., Ltd.

Barges, Stockton, Me.—The Stockton Yard, Inc., has secured a contract to build two 98-foot barges having a capacity of 200 cords of wood for the Pejepscot Paper Company. It is rumored that a coasting schooner is also being built at Sandy Point for the same company.

To Build Six Tankers, Everett, Wash.—The Norway-Pacific Company has contracted to build six 12,000-ton deadweight tankers for unnamed Norwegian interests. The first keel will be laid soon, and the schedule calls for deliveries beginning in August, 1921, the last vessel to be completed in 1922.

To Build Ships, West New York, N. J.—The electric Steel Shipbuilding Corporation, has been incorporated in Delaware, with a capital stock of $600,000, by Frank Knoton, West New York; L. P. Sniffin, Yonkers, N. Y., and H. W. Jarvey, to build steel vessels of various types.

Steel Hull for Dredge, South Portland, Ore., has been leased by the Pacific Marine Iron Works for the construction of a new steel hull for the port of Portland dredge Columbia. Contract price for this dredge, including the renovation of machinery, is $425,000.

Tankers, Oakland, Cal.—A contract for the construction of six oil tankers for the Anglo-Saxon Petroleum Company, Ltd., London, was recently let to the Union Construction Company, Oakland, Cal., and the Southwestern Shipbuilding Company, San Pedro, Cal., each company having been given three to build.

Tugs and Equipment, New York.—The Dolphin Transportation Company, 15 Whitehall street, recently incorporated under the laws of New Jersey, has contracted for two 750-horsepower tugs, 100 feet long; one open lighter with 5-ton gasoline hoist; three covered barges; three dock lighters and one coal barge.

Reconditioning Steamer, Seattle, Wash.—Steven Birch, of New York, president of the Alaska Steamship Company, Seattle, Wash., has been asked to approve the expenditure of $300,000 for the overhauling and reconditioning of the steel steamship Victoria, now on her last voyage to Nome and St. Michael for the present year.

Programme Reduced, Japan—Directors of the Nippon Lusen Kaisha have decided to reduce their shipbuilding programme from 500,000 tons to 100,000 tons. All orders in Japan on which work has not been commenced will be postponed, and no new orders will be placed until the shipping situation shows improvement.

Tankers, San Francisco, Cal.—The Union plant of the Bethlehem Shipbuilding Corporation, was awarded a contract by the Standard Oil Company of California for the construction of three 15,000 deadweight ton tankers. Work will be started immediately, and it is anticipated that the first vessel will be ready by June, 1921.

Repairing Steamer, Oakland, Cal.,—The Moore Shipbuilding Company, was awarded a contract for repairing the Dutch steamer, Arakan, at a cost of $297,854. Repairs will include 109 bottom plates and 110 frame floors and reverse frames, and it will be necessary to remove the funnel, main engines, boilers and thrust shaft for realignment.

Repairing Tanker, San Francisco, Cal.—The Moore Shipbuilding Company was awarded the contract for repairing the Shipping Board tanker Imlay. The specifications called for changing the turbine to a reciprocating engine, and other minor repairs to the 10,000-ton oil carrier. Bids on the job ranged from $82,623, submitted by the Moore yards, to $128,710.

Contracts for Engines, New York.—Seabury & De Zafra, Inc., 150 Nassau street, have placed contracts for two 450 indicated horsepower fore and aft compound marine engines, with the John W. Sullivan Company, New York, and two 12-foot Scotch marine boilers with the Kingsford Foundry & Machine Works, Oswego, N. Y. They have also purchased two Skandia 240-horsepower fuel oil engines for Mexican interests.

Packing for Shipping Board Vessels.—The Shipping Board has awarded contracts for furnishing packing of various kinds to the Board's vessels at domestic ports for the year beginning October 15. The Anchor Packing Company and the United States Rubber Company, who were the successful bidders, will divide between them the entire purchase, amounting to about $2,000,000.

Buys Steel Vessel.—The North Atlantic & Western Steamship Company, operating from Boston to the Pacific Coast ports of Los Angeles, San Francisco, Portland and Seattle, has purchased from the Shipping Board the new steel steamer M. C. Brush, for $185 per ton. She is an oil burner of 7,825 deadweight tons, having a speed of 12 knots, and is 401 feet long, 54 feet beam, and 24.5 feet depth of hold.

Schooner, Camden, Me.—A four-masted schooner, of about 1,000 tons, will be launched October 28, at the R. L. Bean Shipyard. The vessel is principally owned by Camden people, but will be managed by Dunn & Elliot, of Thomaston, Me. The schooner is 200 feet length of keel, 41 feet beam and 21 feet deep, and will be named the T. M. Bransdall. The keel for a similar vessel will be laid as soon as the ways are clear.

Reconditioning Vessels, New York.—The Atlantic Transport liner Minnekahda has finished her last trip under the British flag. She will get American registry, and after reconditioning will be transferred to the American lines New York-Hamburg service. The steamer is a twin-screw of 17,000 gross tons, and is 600 feet long. When reconditioned she will have a passenger-carrying capacity in cabin and steerage of more than 3,000.

Motorships. New York.—It is reported that the Kerr interests, of which H. F. Kerr and Alfred E. Clegg, 17 Battery Place, are president and vice-president, respectively, plan the creation of a fleet of motorships. It is stated that they have been investigating the new Diesel engine evolved by the Bethlehem Shipbuilding Corporation, with the object of placing contracts for several freighters equipped with the new two-cycle internal combustion engine.

Refrigerating Steamers, Elizabeth, N. J.—Two twin-screw refrigerator steamers are under construction at the Moore plant of the Bethlehem Shipbuilding Corporation, for the International Products Steamship Company, a subsidiary of the International Products Company, 120 Broadway, New York. The steamers are of the single deck type and built of steel throughout. They will have a length over all of 54 feet; beam, molded, 40 feet; depth, molded, 18 feet 7 inches; draft, loaded, 8 feet 6 inches.

New Company Buys Shipyard, Baltimore, Md.—The National Ship Supply and Machinery Company, of New York and Chicago, has bought the plant and contents of the old Maryland Shipyard and Supply Base at Soller's Point, Baltimore. The plant consists of 2,800 feet of waterfront and 25,000 feet of railroad siding, together with a large amount of machinery. The company has the following officers: President, Albert A. Rasher; vice-president, John F. Connell; treasurer, Fred Mayer; secretary, William Rosenfeld.

Keels of Battle Cruisers Laid.—The keels of the battle cruisers Constitution and United States have been laid at the Philadelphia Navy Yard. The cruisers will each be 874 feet long and have a tonnage of 43,000, the engines will be of 180,000 shaft horsepower, capable of developing a speed of at least 33 knots. Each vessel will have an armament of eight sixteen-inch guns. The keel for the Saratoga, another of these cruisers, of which there are six to be built for the Navy, was laid at the Camden yard of the New York Shipbuilding Corporation. The vessels will burn oil.

Oil Barges, Staten Island, N. Y.—A contract for the construction of four bulk oil barges for the Standard Oil Company of New York has been placed with the Staten Island Shipbuilding Company. The dimensions of each barge will be: Length of hull, molded, 150 feet; beam, molded, 27 feet; depth, molded 11 feet 6 inches; rise of bottom, 4 inches; pitch of deck, 4 inches. Each barge will be built to carry 250,000 gallons of oil for five tanks. They will be of car-float type, with deck house aft for crew, pump on the deck amidship, expansion trunks and complete equipment.

Composite Ships Sold, Cleveland, Ohio.—Under conditional arrangements, Louis M. Atha, of Cleveland, has agreed to purchase about ten composite vessels of from 3,500 to 4,000 deadweight tons from the Shipping Board for the sum of $140,000 cash each. An initial cash payment of $3,500 has been made on one ship, and upon personal inspection of the vessels Mr. Atha will take over one of the vessels, completing at that time the cash payment for the full amount. At that time he will also pay $31,500 additional to be applied at the rate of $3,500 each on the remaining nine ships. It is reported that Mr. Atha has negotiated for the sale of these vessels to foreign buyers.

New Type Freighters, Sparrow's Point, Md.—The four 20,000 deadweight ton ships to be built by the Bethlehem Steel Company are to be of a new type, carrying ore from Chile and fuel oil back. The ore bins will be run longitudinally through the center of the ship, being carried high up, as is usual in ore carriers to prevent excessive rolling. The space to both sides and below the ore bins will be double riveted, calked, and divided into tanks for the carrying. About 19,000 tons of ore will be carried on the north run, and approximately 130,000 barrels of oil back. The ships, which will have a speed of between 10½ and 11 knots an hour, will be driven by West heavy-oil internal-combustion engines similar to those that have given such good service on the Cubore, recently put into service by the company on the Cuban run. Twin screws will be used, and somewhat more than 6,000 horsepower will be developed. No passengers will be carried.

Additional contracts on hand will keep the yard busily employed well into the year 1922.

SHIPYARDS AND DRY DOCKS

Shipyard Addition, Oakland, Cal.—The Moore Shipbuilding Company, has filed plans for the erection of a power house.

Machine Shop Addition, East Boston, Mass.—The Simpson's Patent Dry Dock Company is building a 24 x 66 feet addition to its machine shop.

Increase of Capital, Philadelphia, Pa.—The Philadelphia Ship Repair Company, Mifflin Street Wharf, has increased its capital from $200,000 to $600,000.

Machine Shop Equipment, Etc., Beaumont, Tex.—The Beaumont Shipbuilding & Dry Dock Company will erect a machine shop and install equipment at its plant at an estimated cost of $100,000.

Repair Plant Resumes, Crisfield, Md.—The old Crisfield shipbuilding plant has been rebuilt and rearranged by Wallace M. Quinn, who recently purchased the property, and has resumed vessel repair work.

New Shipyard Plant, Frankfort, Ky.—The Frankfort Elevator Coal Company will establish a shipbuilding plant for building boats and barges. They have leased a building and will soon install machinery.

New Shipbuilding Company, Pawtucket, R. I.—The Mackinac Company was recently incorporated with a capital stock of $50,000 by Lowell Emerson, William K. Toole, and Archibald C. Matterson to build vessels, etc.

To Establish Plant, Jacksonville, Fla.—The Saliger Ship Salvaging Corporation, 542 West Twenty-third street, New York, has secured 300-foot waterfront site at Jacksonville, Fla., to establish a dry dock, repair and salvaging plant.

Dredging, Oakland, Cal.—The Moore Shipbuilding Company closed a contract with the American Dredging Company, of Oakland, Cal., for a six or eight months' job of excavating along the quay wall at the foot of Market street.

Floating Dry Dock, Sparrow's Point.—The last of the pontoons for the new floating dry dock of the Bethlehem Shipbuilding Corporation, Ltd., has arrived. It is expected that the dock will be ready for operation by the middle of December.

Shipyard Leased, New Bern, N. C.—The Newport Shipbuilding Corporation has leased the former shipyard of the Liberty Shipbuilding Company, Wilmington, N. C., recently taken over by the city. It plans for immediate operations.

Dry Dock, Clifton, L. I.—Another section of the new dry dock of the New York Harbor Dry Dock Corporation has been delivered to the company's plant at Clifton, L. I. When completed the dock will be capable of lifting a ship of 10,000 gross tons.

New Building Plant, Baltimore, Md.—The Marine Transportation Company, 908-10 So. Broadway, has been incorporated, with $450,000 capital stock, to build and repair vessels. The incorporators are Clarence B. and Arthur E. Gore and George H. Kastendike.

Shipyard Expansion, Pensacola, Fla.—The Bruce Drydock Company, has bought the property of the Deep Water Shipbuilding Company, which adjoins the Bruce Drydock waterfront, and will use the place for extensions of its present equipment.

Marine Railway, Wilmington, N. C.—The Stone Towing Company will construct a marine railway about 400 feet long with a cradle of from 250 to 300 feet, and estimated to cost about $60,000. The company will also erect machine and woodworking shops.

To Raise Steamer, New York.—The Saliger Ship Salvage Corporation, 542 West 23d St., has bought the wreck of the former Coast and Geodetic Survey ship, Isis, sunk off St. Augustine, Fla., and will attempt to raise and repair her. Methods invented by Mr. Saliger will be used.

Addition to Power Plant, Philadelphia, Pa.—The Wm. Cramp & Sons Ship & Engine Building Company, Richmond and Norris streets, has awarded a contract for a two-story 60- by 120-foot addition to its power plant to Fred A. Havens, 845 North Nineteenth street.

Bids for Shipyard, Savannah, Ga.—Bids were opened by the Shipping Board for the yard occupied by the National Shipbuilding & Drydock Company. J. W. Ridolph & Company, of Savannah, offered $70,000, and Harris Bros. & Company, of Chicago, made a bid of $40,000.

Shipyard Bids, Mobile, Ala.—The Shipping Board has opened bids on the shipyard formerly operated by Fred T. Ley & Company at Mobile, Ala. A. J. Stone, of Philadelphia, bid $181,705, the Alliance Equipment Company, of Mobile, $101,500, and William M. Turner, of Mobile, $110,025.

New Shipbuilding and Repair Company, Baltimore, Md.—The Marine Transport Corporation, 908-10 South Broadway, has been incorporated with a capital of $450,000 by Clarence B. Gore, Arthur E. Gore and George H. Kastendike, to construct and repair steamers, cargo vessels, etc. It is proposed to establish a local yard.

Shipyard Extension, North Cove, Conn.—Dauntless Shipyard, Inc., has let contract for constructing yacht basin, marine railway, storage sheds, locker building, also dredging in North Cove on Connecticut River, to T. A. Scott Co., Inc., 292 Pequot Avenue, New London, Conn., about $50,000.

Buying Shipyard, Hilton, N. C.—R. R. Stone, principal owner of the Stone Towing Company of Wilmington, N. C., announces that negotiations are nearly complete for his purchase of the property of the Suffolk Shipbuilding Company, on the Cape Fear River, just north of the city, at Hilton.

Floating Dock Finished, Baltimore, Md.—The Globe Shipbuilding & Dry Dock Company, which has assembled its big six-pontoon dock, has taken its first steamer out of water for repairs and painting. It was the Shipping Board steamer Corcoran, and was made ready for the workmen in forty minutes.

Marine Railway, Etc., Essex, Conn.—The Dauntless Shipyard, Inc., let contract for constructing a yacht basin, marine railway, storage sheds, locker building, also dredging in North Cove on Connecticut River, to T. A. Scott Company, Inc., 292 Pequot avenue, New London, Conn.; about $50,000.

New Company to Build Steel Ships, West New York, N. J.—The Electric Steel Shipbuilding Corporation, recently was incorporated in Delaware with a capital stock of $600,000, by Frank Knoton, West New York; L. P. Sniffin, Yonkers, N. Y., and H. W. Jarvey to build steel vessels of various types.

Shipbuilding Company Reorganized, Northport, L. I.—The Northport Shipbuilding Corporation has been dissolved and has been succeeded by the Northport Shipyards, Inc., organized with a capital stock of $100,000 by H. E. Bogdish, M. D. Flomenhaft and G. N. Dorney, 244 West 134th Street, New York.

New Shipyard Company, Bayside, L. I.—The Bayside Shipyard Company has been organized to provide winter storage and repairs for motor and sail boats. Thomas Runney, of the Siemund Electric Welding Company; John W. Ripley, of the Robins-Ripley Engineering Company; William H. Johns, of the George Batten Advertising Agency, and Robert B. Everett, are the officers of the concern.

Buys Shipbuilding Plant, Pascagoula, Miss.—Announcement that the Kelly Shipbuilding & Dry Dock Company, Mobile, Ala., had purchased the plant of the International Shipbuilding Company, was made by E. A. Whitney, president of the Kelly concern. It is understood that the price paid for the plant is approximately $65,000 with the assumption of other obligations, although the machinery of the plant is said to have been valued at more than $250,000.

Shipyard Expansion, Eagle Island, N. C.—The Hamme Marine Railway Company, the marine repair plant of which J. F. Hamme, of Wilmington, N. C., is president, contemplate extensive improvements and additions to their yard. Plans include metal and woodworking shops, electrically operated machinery, an 800-ton marine railway to be constructed in two sections, 70 feet and 80 feet long to cost $30,000 to $40,000; there are 2,000 feet of docking space.

Shipyard Improvement, Clinton, Tex.—Extensive additions, including a floating shop fully equipped with machine shop, boiler making and blacksmith tools, joiner shop and other requirements for making repairs alongside vessels without interfering with loading and unloading activities, will be made to existing equipment in the yards at Clinton on the Houston Ship Canal, by Gray's Engineering Works, of Galveston, Tex. The company has established an office at Houston.

PORT IMPROVEMENTS

Dock, Pensacola, Fla.—The city let contract for building a municipal dock at a cost of $250,000 to the Pensacola Shipbuilding Company.

Wharves, Vicksburg, Miss.—The city proposes to repair and improve its wharves, landings, terminals, etc., at an estimated cost of $100,000.

Dock, Bellingham, Wash.—The city has decided to form a port district and to construct a large ocean dock in addition to rebuilding two piers at Blaine.

Freight Shed and Wharf, Portland, Me.—The Grand Trunk Railroad, India street, will build a one- and two-story 25- by 400-foot steel and timber freight shed and wharf.

Pier, Gulfport, Miss.—A municipal pier will be built here, with lumber derived from cutting timber on the site of the Centennial Exposition Company's proposed buildings.

Dredging.—The Belzoni (Miss.) Drainage Commission plans to redredge 112 miles of ditches, 14 foot bottom, 7 feet deep. S. Castleman, president; C. E. Miller, engineer.

Warehouse, New Orleans, La.—The Dock Board will build a huge warehouse for coffee and sisal storage, capable of accommodating the entire trade at the port in these commodities.

Wharves, Docks, Piers, Etc., Baltimore, Md.—William F. Broening, Mayor, Board of Awards, will vote on $2,500,000 bonds to acquire sites and construct wharves, docks, piers, bridges etc.

Wharf, Ottawa, Canada—The Department of Public Works let contract for repairing the wharf at St. Francois D'Orleans, Quebec, to S. Rattee, St. Ann de Beaupre. About $33,000 cost, plus percentage basis.

Coal Piers, Port Covington, Baltimore, Md.—The Western Maryland Railway, H. A. Lane, chief engineer, will expend $622,800 for extensive improvements, including the extensions to coal piers, dredging, etc.

Wharves, Etc., Manchester, Tex.—The city of ouston, Tex., will build two wharves and a coaling station, and remodel the cotton sheds, etc., at Manchester; $1,250,000 bonds will be voted. Address the Mayor.

Pier and Sheds, Portland, Ore.—Plans for the new pier and sheds at Terminal No. 4, are being perfected. These constitute part of the harbor improvements contemplated by the Dock Commission when they voted $2,000-000 bonds.

Pier and Transit Sheds, Vancouver, B. C.—The Harbor Commissioners, 712 Pender street, W., let contract for building reinforced concrete pier and transit sheds to the Northern Construction Company, Ltd., Carroll street; about $4,500,000.

Floating Dock, Etc., Montevideo, S. A.—Port works planned for Montevideo, Uruguay, S. A., include a floating dock, repair yard, deepening of the channel and several other improvements. This project involves the expenditure of about $34,000,000.

Harbor Development Manila, P. I.—At the last session of the Phillippine Legislature $6,000,000 was appropriated for improvement work in developing the harbor of Manila. The harbor will be dredged to a depth of 40 feet, and the present sea will be greatly extended.

Bulkhead, South Boston.—The Boston Molasses Company, 175 Milk street, Boston, Mass., let contract for building a reinforced concrete bulkhead on First street and Farragut Road to the Aberthaw Construction Company, 27 School street, Boston; about $50,000.

Improve Ship Channel, Etc., Houston, Tex.—The Harbor Board has recommended to the mayor that a $2,500,000 bond issue be made to cover the costs of additional improvements by the city on the ship channel and the Municipal Railway, and for the purchase of additional channel frontage by the city.

Ocean Terminal, Seattle, Wash.—Immediate construction of the west half of the superstructure at Pier B. Smith Cove Terminal, the largest commercial dock in the world, for the accommodation of transpacific passenger liners, has been assured by the purchase of $350,000 port of Seattle bonds by a combination of Seattle banks.

Big Terminal Project, Jacksonville, Fla.—The Jacksonville Port Development Company has been organized by a group of Florida business men for the purpose of acquiring terminal, warehouse and other facilities. E. S. Sharlow is president. It is also planned to buy, sell, build, repair and operate water carriers of all kinds.

Wharves, Auckland, N. Z.—The Harbor Board has been authorized to place a loan of $4,866,500 for the development of the harbor at Auckland. Plans are well under way for the completion of wharves and sheds, as well as the construction of three more wharves in order to meet the demands of the constantly increasing commerce.

Equipment for New Docks, Staten Island, N. Y.—In connection with harbor developments at Staten Island, the New York Harbor Commission, Murray Hulbert, Commissioner of Docks, will install mechanical equipment for freight handling, comprising cranes, monorail tracks and cars, elevators for motor truck transfer to different levels, hoisting machinery, etc.

Inland Waterway Improvement—Construction of the Illinois $2,000,000 waterway will soon begin. The project will extend from Lockport on the Desplaines River to La Salle on the Illinois River, a distance of 65 miles. It will connect 15,000 miles of improved waterways in the Mississippi Valley, and make continuous navigation possible between the Mississippi River and the Great Lakes.

Steamship Terminal and Equipment.—Plans for the proposed terminal of the Luckenbach Steamship Company, 44 Whitehall street, New York, on the New Jersey shore of the Hudson river, will include three piers, each 1,200 feet long, with sheds, warehouses, etc., and will cost about $10,000,000. Hoisting and conveying machinery, and other freight handling equipment will be installed at the terminals.

Dock, New Orleans, La.—Port Commissioners, let contract for erecting, painting and doing all steel work required on Poydras street shed, and extension of New Orleans dock, involving 240 tons of steel, to the Pensacola Shipbuilding Company, Blount Building, Pensacola, Fla., $39,600; side extension involving 110 tons steel to Alexander & Julian, 1104 Webster street, New Orleans, $22,320.

Pier Leased, Brooklyn, N. Y.—Announcement has been made that the Army Base, Pier 4, South Brooklyn, has been leased by the War Department to the Kerr Navigation Company, whose stock was recently acquired by the Harriman concern, the American Ship & Commerce Corporation. The pier is one of the finest on the Atlantic coast. It is 1,300 feet long, double-decked and equipped with every modern convenience.

SHIPPING DEVELOPMENTS

Increase of Capital, New York—The American & Cuban Steamship Line, 39 Cortlandt street, has increased its capital from $25,000 to $1,500,000.

Increase of Capital, New York—The Atlantic & Caribbean Steam Navigation Company, 82 Wall street, has increased its capital from $2,000,000 to $10,000,000.

Increase of Capital, Beaumont, Tex.—The capital stock of the Gulf Export & Transportation Company has been increased from $600,000 to $1,000,000 representing local investments.

Steamship Company Formed, New York—The Dominican Steamship Company has been formed by August E. M. Thiery, Raymond E. Cook and John F. Wharton, all of New York, with a capital of $300,000.

New Steamship Company, Baltimore, Md.—The West Indian Navigation Company, 3 East Lexington street, has been incorporated, with a capital of $100,000, by Frank E. Welsh, Jr., Richard E. Preece and Thomas H. Sanks.

Seattle-Oriental Service. Seattle, Wash.—The Shipping Board will put five passenger liners of 20,000 tons each on the Seattle-Oriental run, starting with the sailing of the steamship Wenatchee about January 1.

Portuguese-South American Service—The Portuguese State Maritime Transport Company will establish a permanent steamship service between Lisbon and Buenos Aires. The company owns a fleet of over forty vessels.

New Coastal Service, San Francisco, Cal.—The San Francisco & Portland Steamship Company will inaugurate a five-day service between San Francisco and Portland beginning November 1, it is announced by Frank Shafer, manager of the company.

New Steamship Line, New Bern, N. C.—The Elizabeth City Boat Line was recently incorporated with a capital of $50,000 by B. F. McHorney, president, and J. J. Harrison, secretary. The boats will operate between Baltimore, Norfolk and New Bern, N. C.

Steamer Sold, Gulfport, Miss.—The freight steamer Gaston, built of steel, 212 feet long, 847 tons gross, has been sold by the Baltimore Steam Packet Company to the Gulfport Fruit & Steamship Company, of Gulfport, Miss. The Spedden Shipbuilding Company is fitting the vessel for sea.

Central American Line—Contracts for the establishment of the Central American Navigation Company have been signed by Eusebio Brenes Ortiz and officials of the Costa Rican Government, it is announced in advices from San Jose, Salvador. The company will operate vessels on both the Atlantic and Pacific coasts of Central America.

New Shipping Company, Charleston, S. C.—A new shipping company, recently formed, and is to be known as the Charleston Shipping Company, comprises the following officers: A. F. Pringle, president; H. F. Barkerding, vice-president; E. H. Pringle, Jr., treasurer. H. E. Quensted, secretary of the company, is in charge of the Charleston office.

Government Steamship Line, Chile, S. A.—A proposal is to be laid before the Chilean Congress for the creation of a Government-controlled steamship line. The proposed concern will maintain monthly sailings from Chilean ports to the United States and Europe. The plans provide for the immediate purchase of a 10,000-ton steamer.

Coast to Coast Service, Portland, Ore.—The announcement of the immediate inauguration of a regular three-week steamship service between Portland, Ore., and the ports of Philadelphia and Boston by vessels operating in the ser ice of the North Atlantic & Western Steamship Company was made recently by officials of the Admiral Line, who act as agents for that company.

New African Service, Baltimore, Md.—A steamship line making regular trips to the Pacific Coast and to South and West Africa has been started by Page & Jones, Mobile, Ala., marking the entry of this port into this trade. The boats sail from Baltimore, making ports along the Atlantic Coast, touch Mobile, and then go through the Panama Canal to the Pacific.

New Steamer Line, Camden, N. J.—Two former Clyde steamships are to be run between Atlantic City and New York and to Philadelphia. They will be transferred to the new company now being formed, which will begin operations next spring. It is reported that the corporation is negotiating for two other steamships. The line will also narry freight. Warren Webster, of Camden, N. J., is interested in the new company.

Lake Steamship Combination, Chicago, Ill.—Negotiations for the sale of the Goodrich Transit Company to the Chicago, Racine and Milwaukee Line are pending. The combination, if effected, will make one of the largest steamship companies on the Great Lakes, and will dominate the lake trade of Chicago, Milwaukee, Detroit, Cleveland, Muskegon, Grand Haven, South Haven, Sturgeon Bay, Manitowoc and practically all ports on the shores of Lake Michigan.

Finland-New York Line—It is reported that a Finnish shipping company plans to establish regular steamship service between Finland and New York. The company has bought an ocean steamer, the Valtameri, which will make four trips a year each way and not call at intermediate ports. There will be accommodations for 100 passengers. It is expected the Finnish Government will grant subsidies to some extent for the enterprise.

Liner Purchased, New York—The ex-German liner Corcovada, rechristened the Guglielmo Pierce, has been added to the fleet of the Sicula Americana, 17 Battery Place, and will make her first trip under the Italian flag to New York some time in November, it is announced by Louis Costa, American representative of the company. The vessel has a displacement of about 21,000 tons, and has especially fine passenger accommodations.

Increasing Cuban Service—The Peninsular & Occidental Steamship Company announces that, in addition to the steamer Governor Cobb, which has been run under lease between Key West and Havana during the winter season, and will be put on a year-round run, the Cuba, now being completed at the Cramp shipyards, Philadelphia, will be ready for service about December 1. Both vessels are equipped for freight and passengers, and both are oil burners.

Shipbuilding Company to Operate Tankers, Baltimore, Md.—It is reported that interests in control of the Baltimore Dry Docks & Shipbuilding Company have formed a $2,000,000 corporation to be known as the Calvert Navigation Corporation to operate a fleet of four tankers which the company will build at its own plant. One of the tankers, the Clement C. Smith, was launched recently, and work on the other three vessels will be expedited. Holden A. Evans will be president of the new company.

Canadian East Indian Service—It is announced that the Canadian Government merchant marine intends to start a direct steamship service between Montreal and Indian ports, through an arrangement between the Government and the British India Company. It will be inaugurated with the sailing of the British India Company's vessel Boyne. The Government and the British India Company will each put four vessels on this route. The line will use Montreal in summer and Halifax, N. S., in winter.

Trinidad Line Bought—Furness, Withy & Company have bought the property and good-will of the Trinidad Shipping and Trading Company and vessels of the Quebec Steamship Company. The Trinidad Company owns a large amount of property on Trinidad Island, and operates a passenger and freight service from New York under the name of the Trinidad Line, with offices at 29 Broadway. It is the intention of Furness, Withy & Company to continue to operate the three Trinidad ships under the name of the Trinidad Line.

GOVERNMENT BUSINESS

Refrigerating Equipment, San Diego, Cal.—Specification 4303, Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to install refrigerating machinery at San Diego, Cal.

Dredging, San Diego, Cal.—N. Smith, public works officer of the United States Navy, was authorized to expend $940,000 for dredging and filing in along sites of marine brigade post and naval training station.

Marine Railway, Hawaii, H. T.—Specification 4254, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until November 17 for completing the marine railway at Hawaii, H. T.

Jetties, Jacksonville, Fla.—United States Engineer, Masonic Temple, let contract to the Seaboard Dredging Company, for raising south jetties 3 feet above high-water level at a cost of $100,000. 15,000 tons of rock will be used.

Navy Yard Expansion, San Francisco, Cal.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has completed plans for the erection of a new mechanical shop at the Mare Island Navy Yard, near San Francisco, Cal.

Steam Locomotive Crane—Specification 4263, Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for installing a 50-gross ton steam operated locomotive jib crane on the tracks at the Naval Dry Dock at South Boston, Mass. C. W. Sparks, chief engineer.

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Marine Engineering

Volume XXV DECEMBER, 1920 Number 12

(*Photograph copyright 1920 by Edwin Levick, N. Y.*)

Fig. 1.—S.S. *Cuba,* at Full Speed, Showing Flat Wake and Small Wave Formation

Electrically Propelled Passenger Ship Cuba

First Passenger Ship in the World to Be Equipped with Electric Drive—Vessel Has Speed of 17¼ Knots

BY JAMES A. KELLEY*

THE steamship *Cuba,* now running between Jacksonville, Fla., and Havana, Cuba, and operated by the Miami Steamship Company, is the latest product of the Morse Dry Dock & Repair Company, Brooklyn, New York.

To the *Cuba* belongs the distinction of being the first passenger ship in the world to be driven electrically, and to the Morse Dry Dock & Repair Company the distinction of installing the machinery, which was furnished by the General Electric Company, of Schenectady, New York.

Characteristics

The principal dimensions of the *Cuba* are as follows:

Length between perpendiculars	299 feet 6 inches
Length overall	328 feet
Beam, molded	40 feet
Depth, molded	26 feet 9 inches
Draft forward	16 feet
Draft aft	18 feet
Mean draft	17 feet

From Figs. 2 and 3 it will be noted that the vessel has a fine underwater body. The block coefficient on the 17-foot waterline is 0.61, giving a displacement of 3,580 tons in salt water.

A sea speed of 17.28 knots was obtained on recent trials with the machinery installation delivering its full power of 3,000 horsepower.

Accommodations

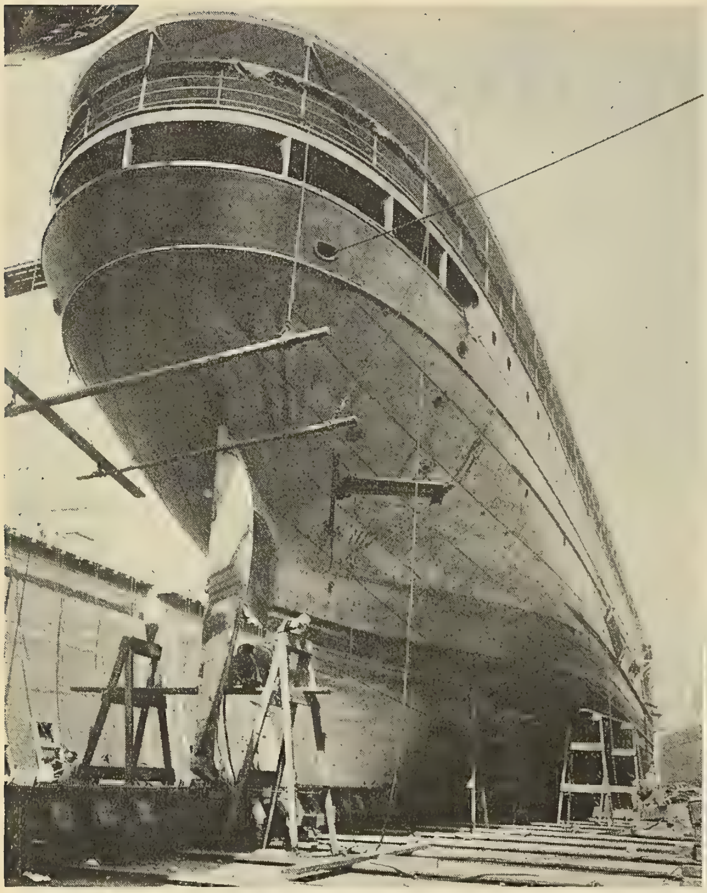
In the design of the vessel and its accommodations considerable attention has been given to the run in which the vessel will be placed. Everything for the comfort and pleasure of the passengers has been accomplished and the vessel could well be called a luxurious yacht rather than a passenger steamship.

It is not contemplated to carry any cargo with the exception of a few automobiles on the main deck forward and a small amount of refrigerated cargo such as tropical fruits, etc., in the refrigerator compartments below decks. To facilitate the loading and discharging of the automobile cargo carried forward, a large auto port has been provided in the side of the vessel. This port is of sufficient size to allow the largest limousine built to be driven aboard instead of being hoisted in the usual way.

General Arrangements

As will be noted from Fig. 5, quarters for the deck officers and the wireless officers are located on the boat deck, as is also the wireless room. A card room, which is decorated in

* Naval architect, Morse Dry Dock & Repair Company, Brooklyn, N. Y.



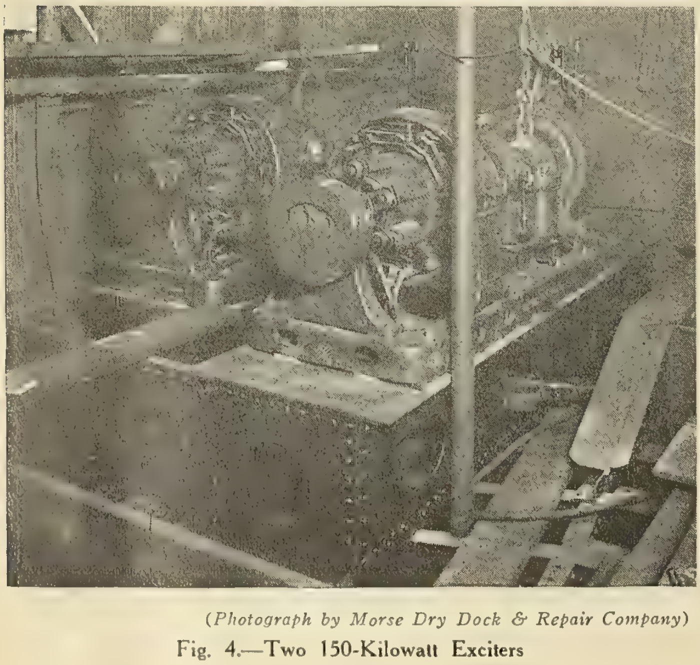
(Photographs by Morse Dry Dock & Repair Company)

Figs. 2 and 3.—Views of the *Cuba* in Dry Dock, Showing Fine Lines of Vessel

white panel work with mahogany wainscoting and fitted with typical card tables, is placed aft of these quarters.

Farther aft on the boat deck is a smoking room with a large bar attached thereto, and aft of this a veranda café. The bar is completely fitted with a mahogany bar and a large ice box which is cooled from the ship's refrigerating plant. The smoking room is done in old English oak with a large skylight trunk extending the full length of the room. All furniture in this room is of wicker in a shade that matches the old English finish of this space.

The veranda café has been designed to represent as nearly as possible, on board the ship, a typical veranda with running vines on trellis work. The windows, as will be noted from the detail plans, are exceptionally large, and when open one will derive the full benefit of the ocean breeze. The furniture in this space is quite attractive, being in ivory and green.



(Photograph by Morse Dry Dock & Repair Company)

Fig. 4.—Two 150-Kilowatt Exciters

On the superstructure forward will be found the special staterooms which are fitted with double berths and private baths. The forward entrance hall on this deck is fitted in circassian walnut panel work and the after entrance hall with Crotch mahogany panels. All the staterooms are fitted with mahogany berths and furniture.

The dining saloon is designed for individual table service, each table being arranged for four or six persons. The chairs fitted are not of the ordinary ship revolving type, but are large comfortable tapestry upholstered chairs. A specially designed indirect lighting system is provided for the dining saloon, which adds considerably to its attractiveness.

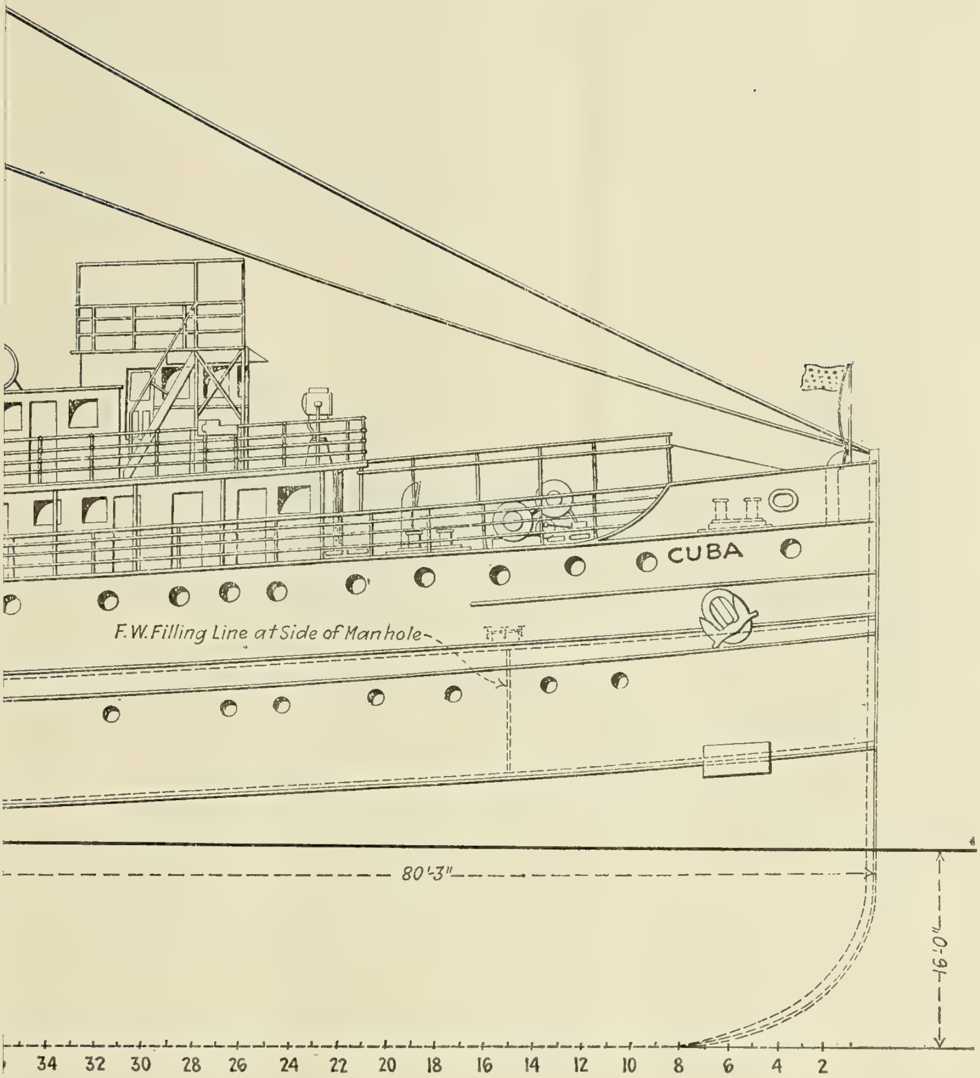
The galley and pantry are situated below the dining room and are equipped in the most up-to-date manner, including glass pantry, silver pantry, scullery, cold pantry and a bake shop with an electric oven as well as an electric roll warmer.

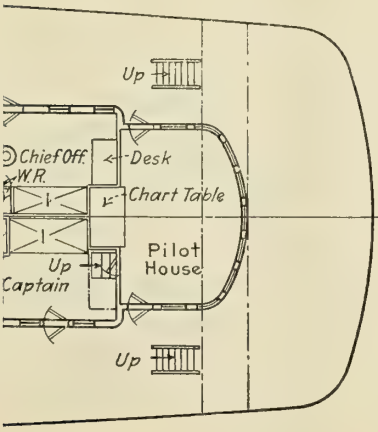
Boilers

The boiler plant consists of four Scotch boilers 13 feet inside diameter and 10 feet 6 inches long, each with three furnaces of the Morison type. The length of grate is 5 feet 6 inches and the grate area for each boiler is 53.7 square feet. The boiler tubes are 2½ inches outside diameter and the total heating surface for each boiler is 1,900 square feet. The boilers operate at a pressure of 190 pounds and are fitted with the White Fuel Oil Company's system of oil burners and with superheaters furnished by the Locomotive Superheater Company, which deliver steam at a superheat of 200 degrees.

Fuel Oil

A fuel oil capacity of 1,772 barrels is provided for the

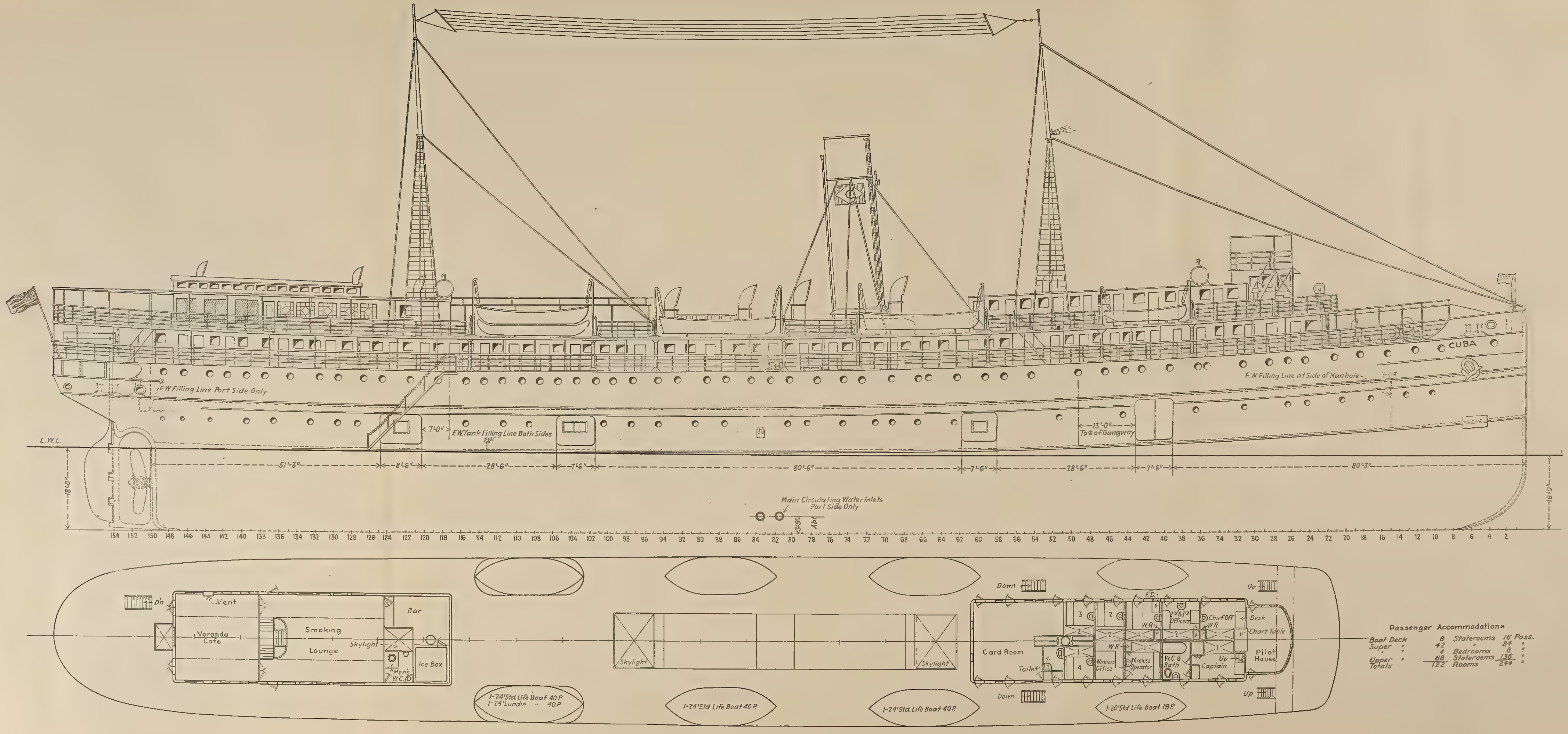




Passenger Accommodations

Boat Deck	8	Staterooms	16	Pass.
Super "	42	"	84	"
" "	4	Bedrooms	8	"
Upper "	68	Staterooms	136	"
Totals	122	Rooms	244	"

ELECTRICALLY PROPELLED PASSENGER SHIP CUBA



BOAT DECK

Fig. 5.

ELECTRICALLY PROPELLED PASSENGER SHIP CUBA

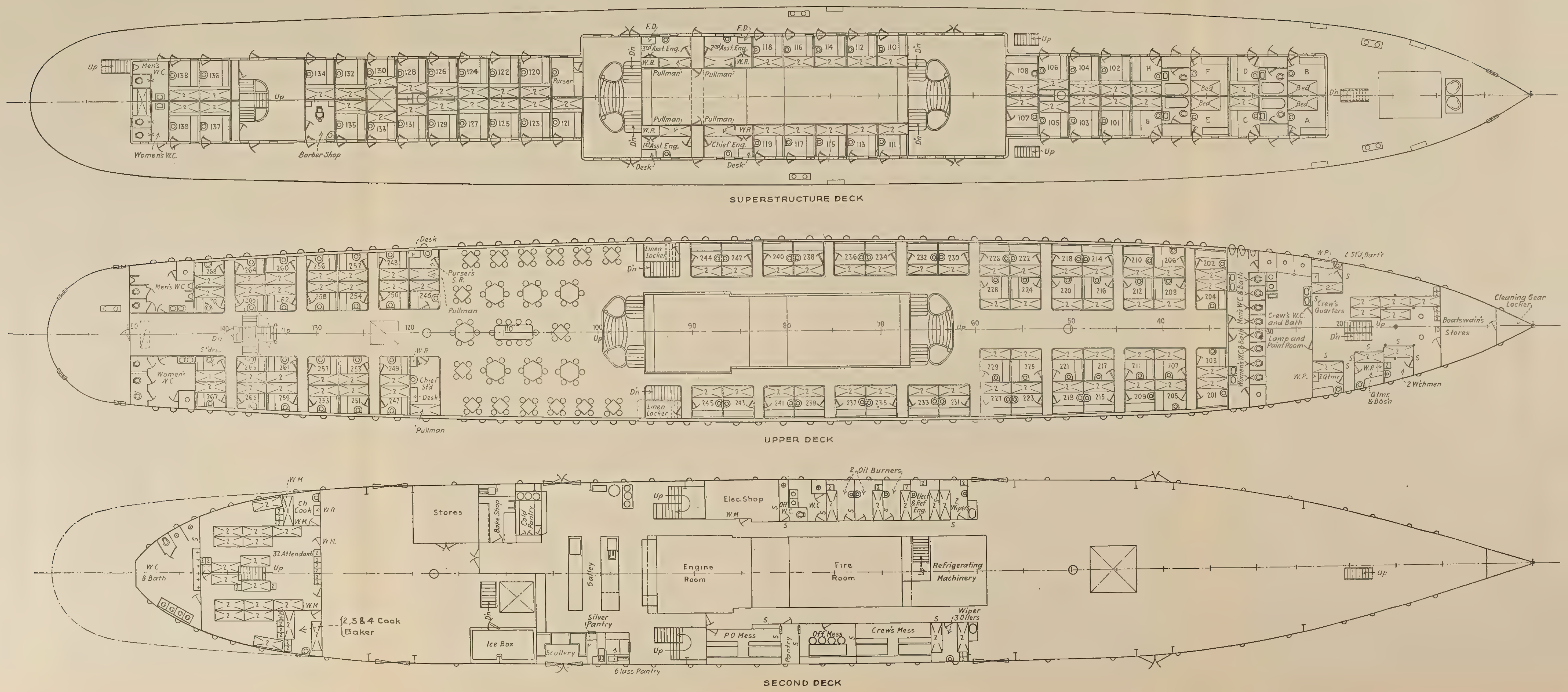
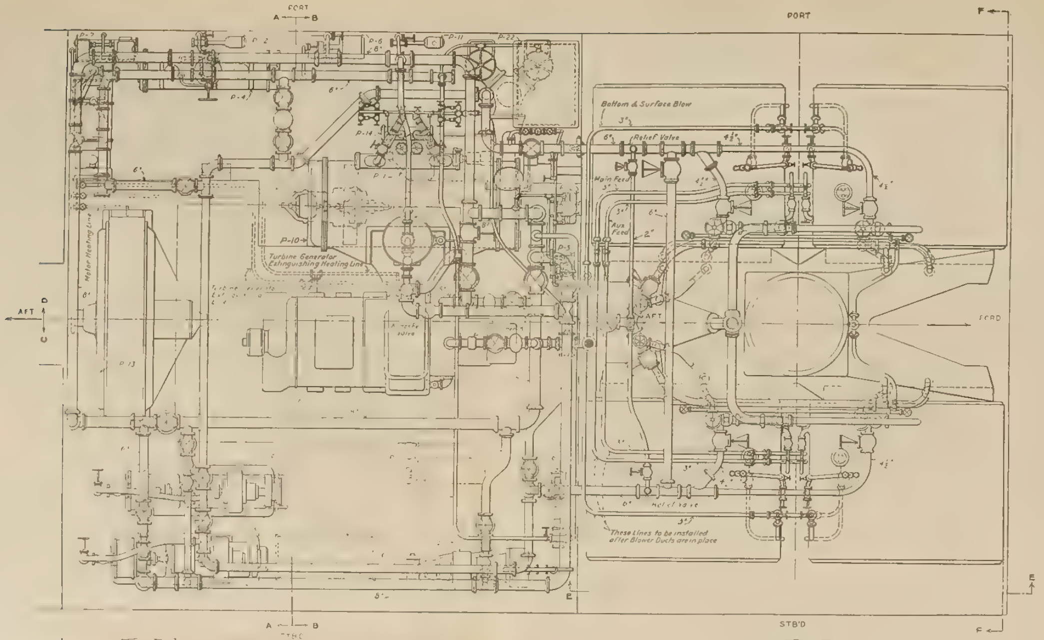
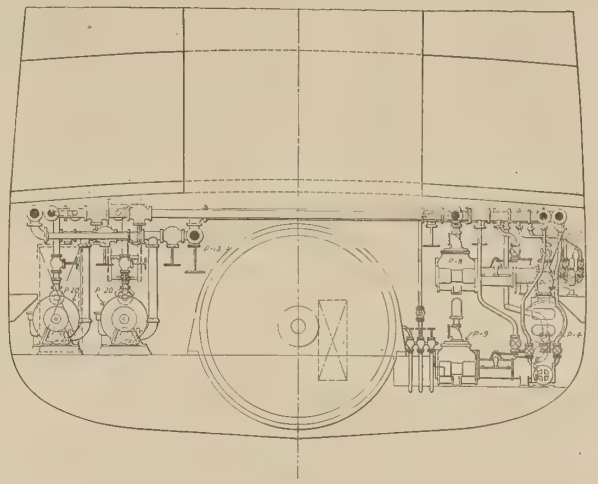


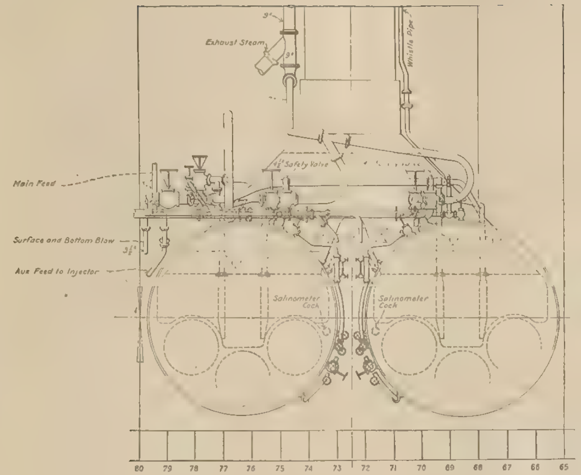
Fig. 6.

ELECTRICALLY PROPELLED PASSENGER SHIP CUBA

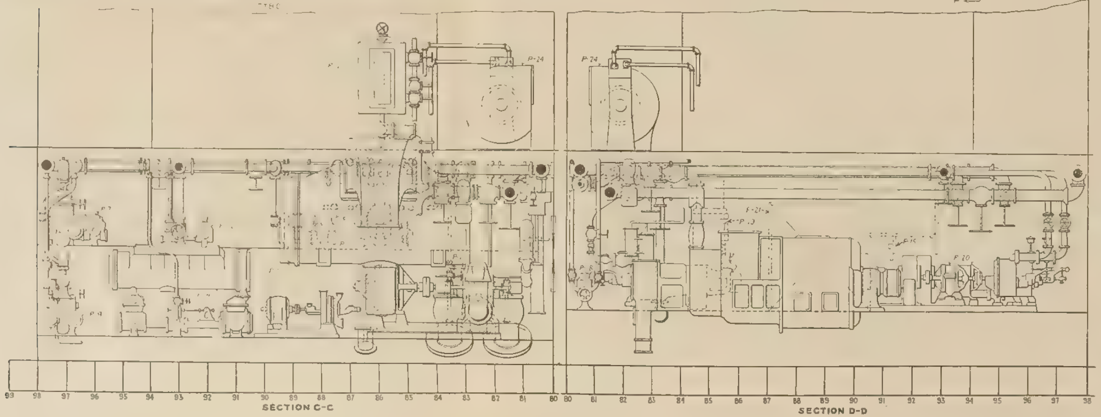




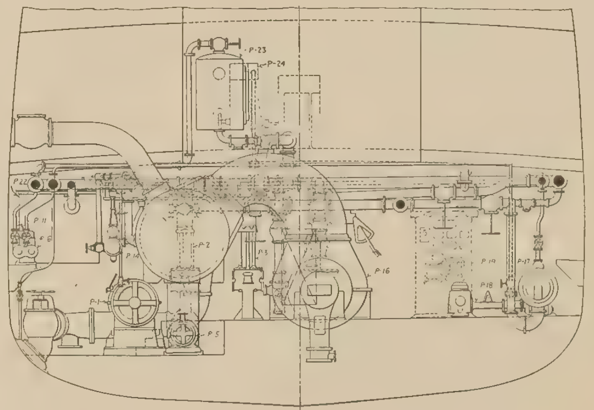
SECTION A-A
Looking Aft.



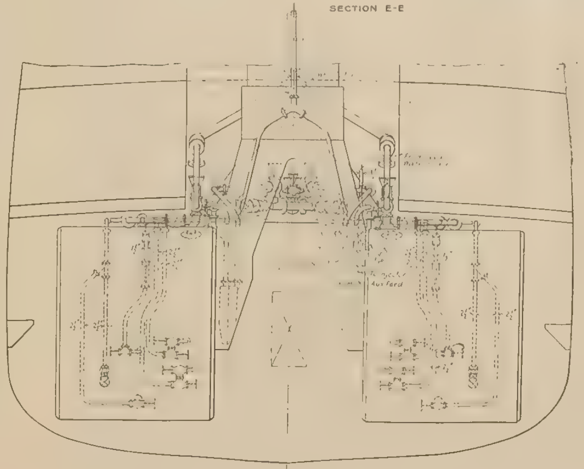
SECTION E-E



SECTION C-C SECTION D-D



SECTION B-B
Looking ford.



SECTION F-F

LIST OF MACHINES, PUMPS, ETC.

Mark and Name	Size	Kind	Size of Steam Connection: Steam	Exhaust	Remarks
P-1 Main circulating pump	20" suc., 16" dis.	Centrifugal	....	....	Motor drive
P-2 Main feed pump	10" x 7" x 24"	Ver simp piston pump	1¼"	1½"	4" suc., 3½" dis.
P-3 Auxiliary feed pump	10" x 7" x 24"	Ver. simp. piston pump	1¼"	1½"	4" suc., 3½" dis.
P-4 Auxiliary surface condenser	10" x 12" x 12" x 12"	Simplex	1¼"	1½"	800 sq. ft. condenser; 8" suc., 6" dis.
P-5 Hot well pump	4" suc., 2½" dis.	Centrifugal	....	....	Motor drive
P-6 Sanitary pump	7½" x 7½" x 6"	Duplex	1½"	2"	6" suc., 5" dis.
P-7 Auxiliary bilge	6" x 5¼" x 6"	Duplex	1"	1¼"	4" suc., 3" dis.
P-8 Fire pump	12" x 8½" x 12"	Duplex	2½"	3"	7" suc., 6" dis

Mark and Name	Size	Kind	Size of Steam Connection: Steam	Exhaust	Remarks
P-9 Bilge pump	12" x 8½" x 12"	Duplex	2½"	3"	7" suc., 6" dis.
P-10 Main condenser	7,000 square feet	Surface	....	....	18" inlet, 18" outlet
P-11 Ref. cir. pump	5½" x 5½" x 7"	Horizontal simplex	½"	¾"	3" suc., 2½" dis.
P-12 Fresh water	5½" x 5½" x 7"	Horizontal simplex	½"	¾"	3" suc., 2½" dis.
P-13 Main motor	8,000 horsepower	....	....	....	....
P-14 Air ejector	....	....	1¼"	....	....
P-15 Control board	....	....	....	....	....
P-16 Turbo generator	3,150 horsepower	....	6"	....	....

Mark and Name	Size	Kind	Size of Steam Connection: Steam	Exhaust	Remarks
P-17 Electric lighting set	....	....	2"	10"	....
P-18 Stand by pump	6" x 6" x 12"	Horizontal simplex	¼"	1"	3" suc., 2½" dis.
P-19 Operating stand	....	....	....	....	....
P-20 Exciter	....	....	....	....	....
P-21 Switch board	....	....	....	....	....
P-22 Filter tank	....	....	....	....	....
P-23 Feed water heater	....	....	....	....	....
P-24 Blower engine	....	....	....	....	....

vessel. This oil is carried in tanks built separate from the hull and located just forward of the boiler room.

Forced Draft

A scheme for ventilating the turbo generator and motor and supplying the preheated air to the boiler has been developed on this vessel and during the trials it proved very efficient. By a series of dampers in the various ducts the hot air is taken from the motor and from the turbo generator and delivered through a 25,000 cubic foot per minute American Sirocco fan to the boilers at a mean pressure head of three inches.

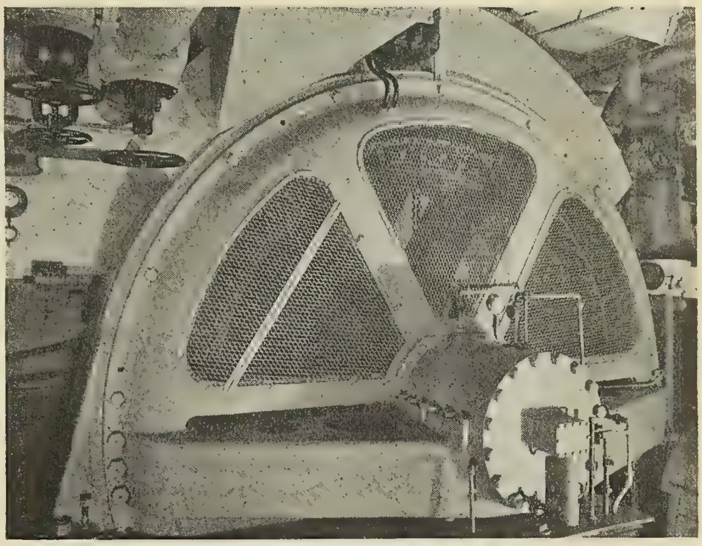
An auxiliary American Sirocco fan supplied by the American Blower Company, Detroit, Mich., has been placed in the after end of the engine casing to provide means for cooling the motor in case of breakdown of the large fan. This fan will discharge the air directly overboard, and in case of insufficient ventilation in the engine room it is used as an exhaust fan.

Main Propelling Machinery

The main propelling machinery consists primarily of a turbo generator, main propulsion motor, two exciters, control equipment and a lighting set. A general description of the operation of the electric propulsion machinery of the *Cuba* follows:

The turbine drives the alternating current generator which supplies current to the synchronous motor through a three wire system. The necessary excitation current for the main generator and motor fields is furnished by one of the exciters, which also supplies the light for the boat and power for the auxiliaries.

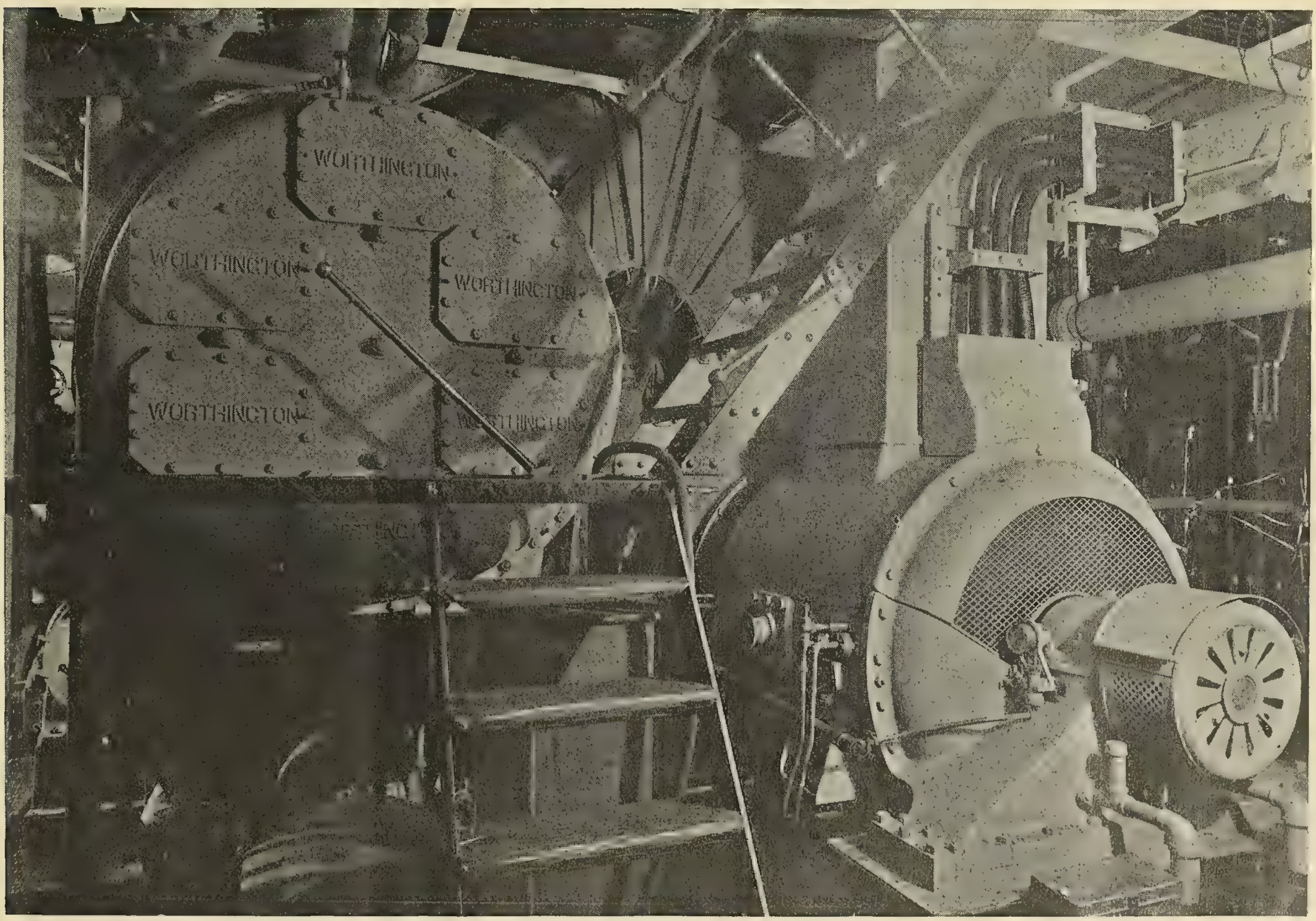
The control equipment enables the engineer to maneuver by simply operating two levers, one for reversing and one for varying the speed. The motor is started, stopped and reversed by means of the high and low voltage contactors of the control group. In starting from rest, the motor operates without its direct current field as an induction motor. When the motor is nearly up to speed field is applied and operation continues as a synchronous motor.



(Photograph by Morse Dry Dock & Repair Company)

Fig. 9.—Propelling Motor

In reversing, the motor is automatically connected to function as a generator returning power to the turbo generator,

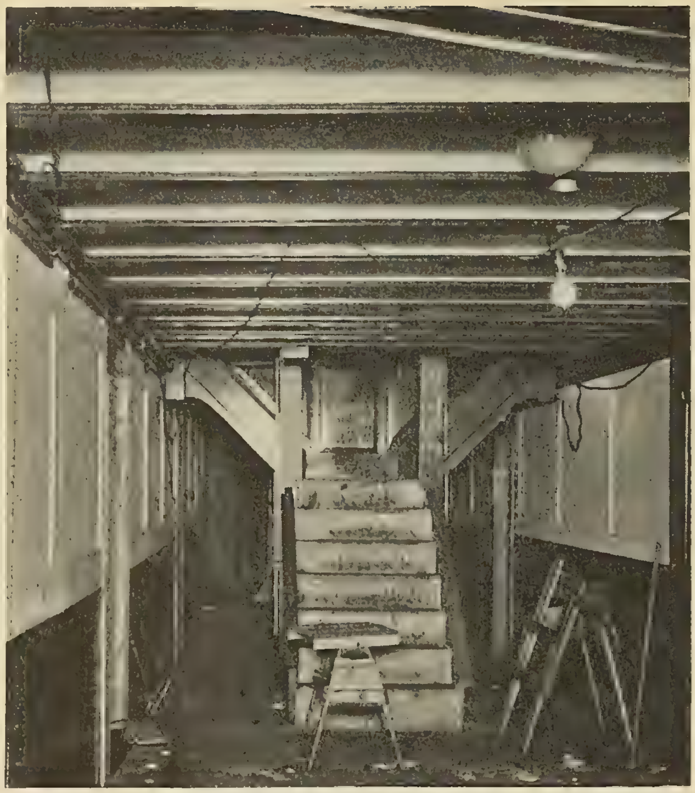


(Photograph by Morse Dry Dock & Repair Company)

Fig. 8.—View of Engine Room, Showing Main Turbo Generator and Condenser

(Photograph by Morse Dry Dock & Repair Company)

Fig. 10.—Stairway Under Construction



(Photograph by Morse Dry Dock & Repair Company)

Fig. 11.—Stairway and Panel Work in Passageway

(Photograph by Morse Dry Dock & Repair Company)

Fig. 12.—Smoking Lounge

(*Photograph by Morse Dry Dock & Repair Company*)

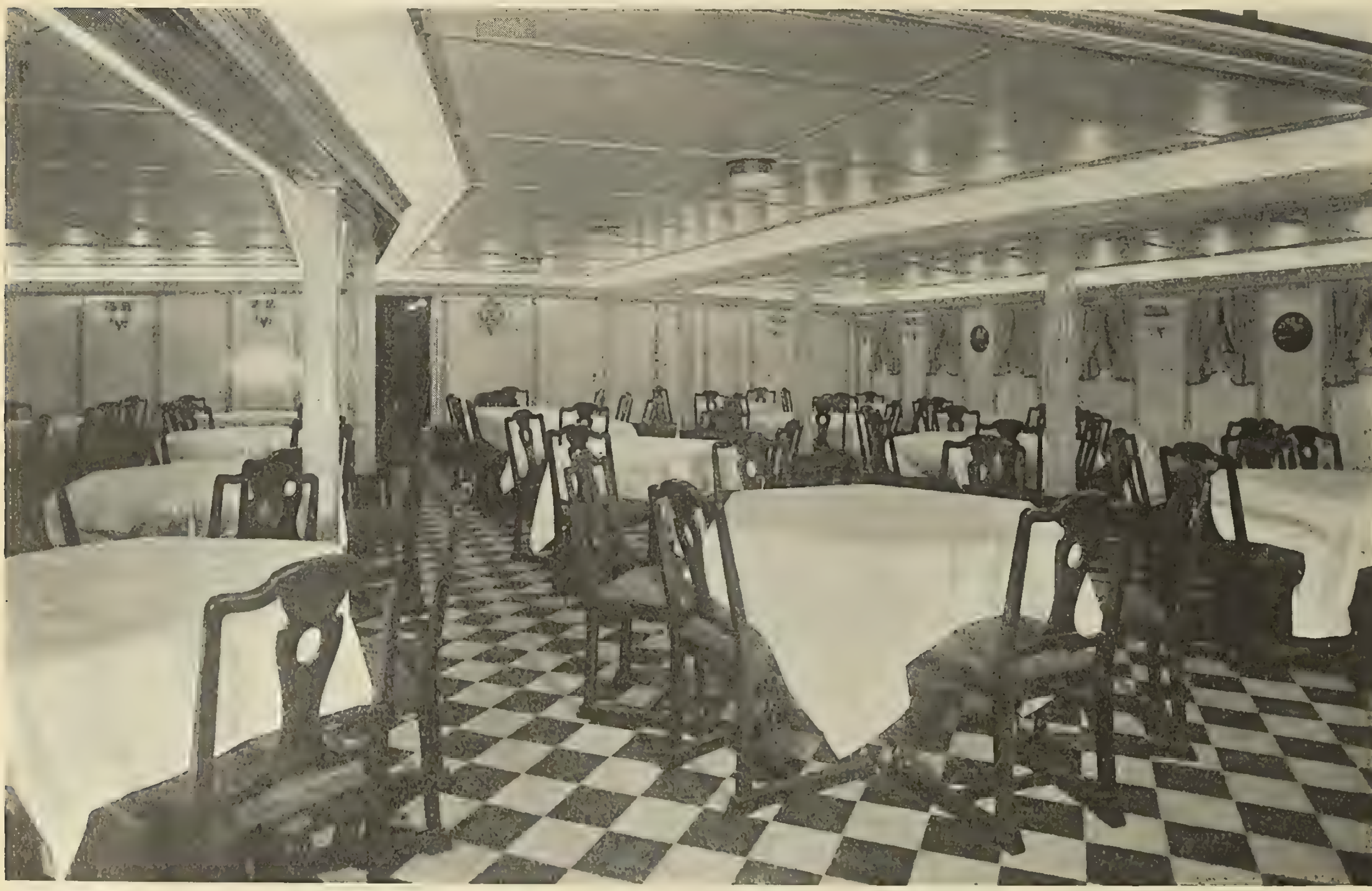
Fig. 13.—Foyer on Superstructure Deck Under Construction

(*Photograph by Morse Dry Dock & Repair Company*)

Fig. 14.—Foyer on Superstructure Deck

(*Photograph by Morse Dry Dock & Repair Company*)

Fig. 15.—Dining Saloon Under Construction

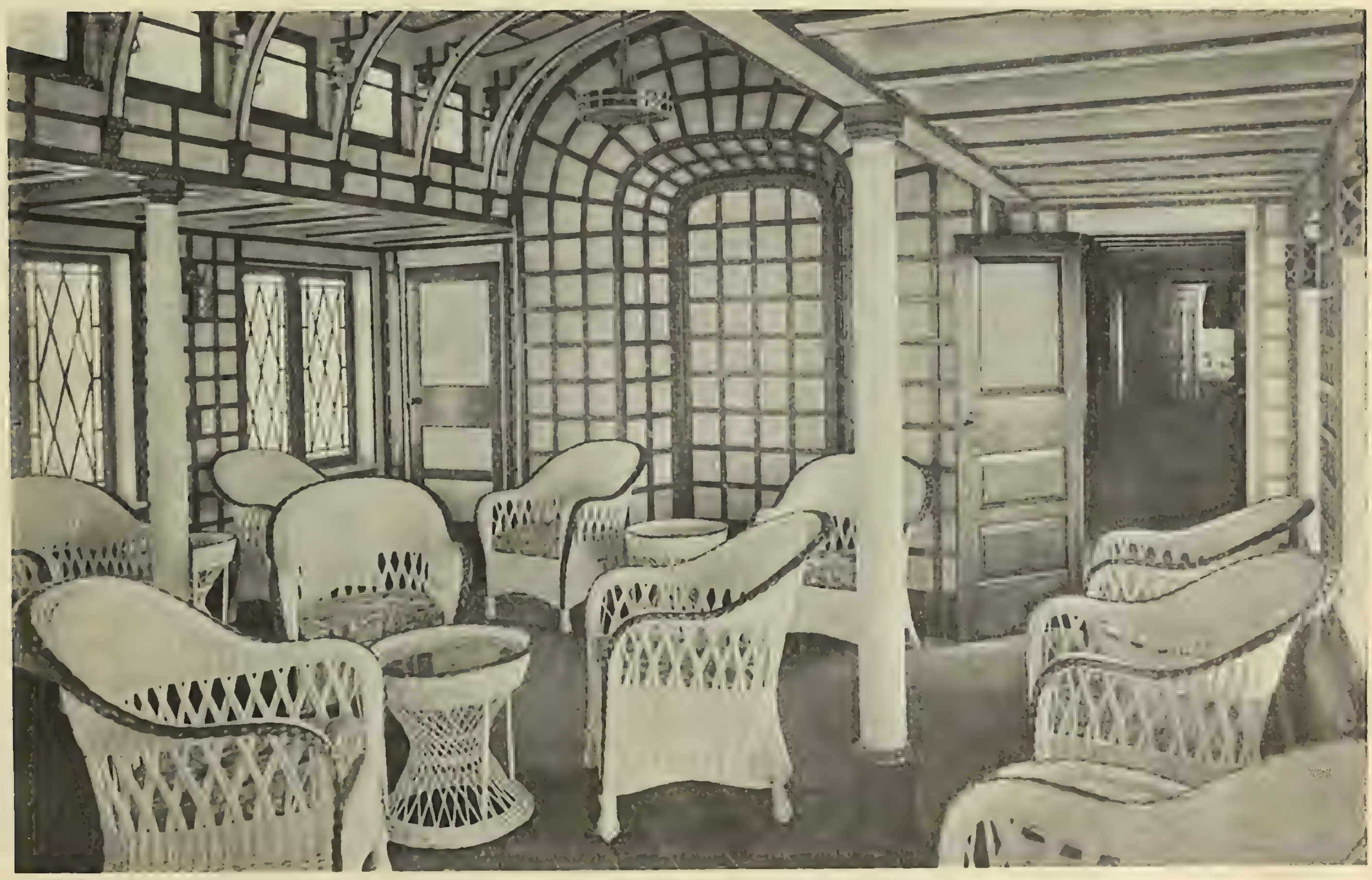


(*Photograph by Morse Dry Dock & Repair Company*)

Fig. 16.—Dining Saloon

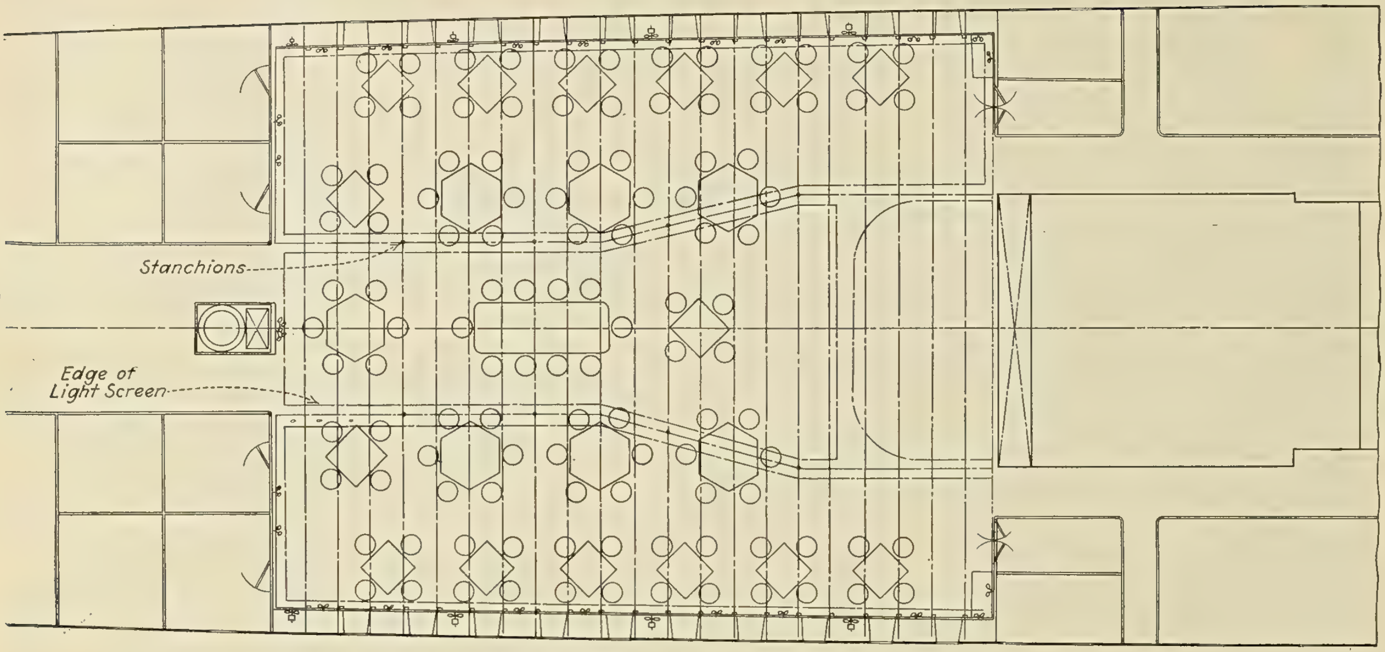
(*Photograph by Morse Dry Dock & Repair Company*)

Fig. 17.—Veranda Café Under Construction

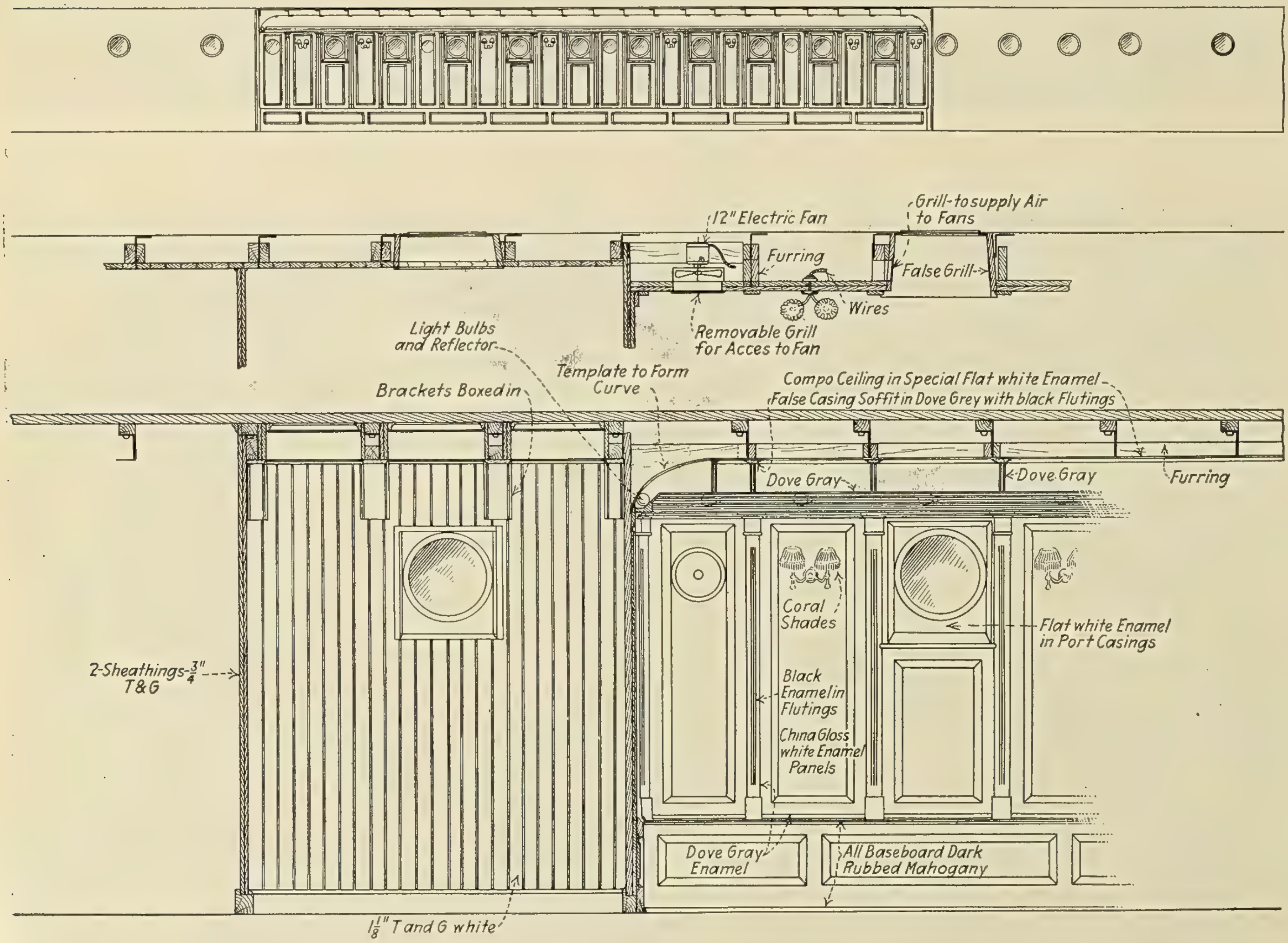


(*Photograph by Morse Dry Dock & Repair Company*)

Fig. 18.—Veranda Café After Completion



PLAN



LOOKING OUTBOARD PORT SIDE

Fig. 19.—Dining Saloon: Plan and Elevation, Showing Joiner Details

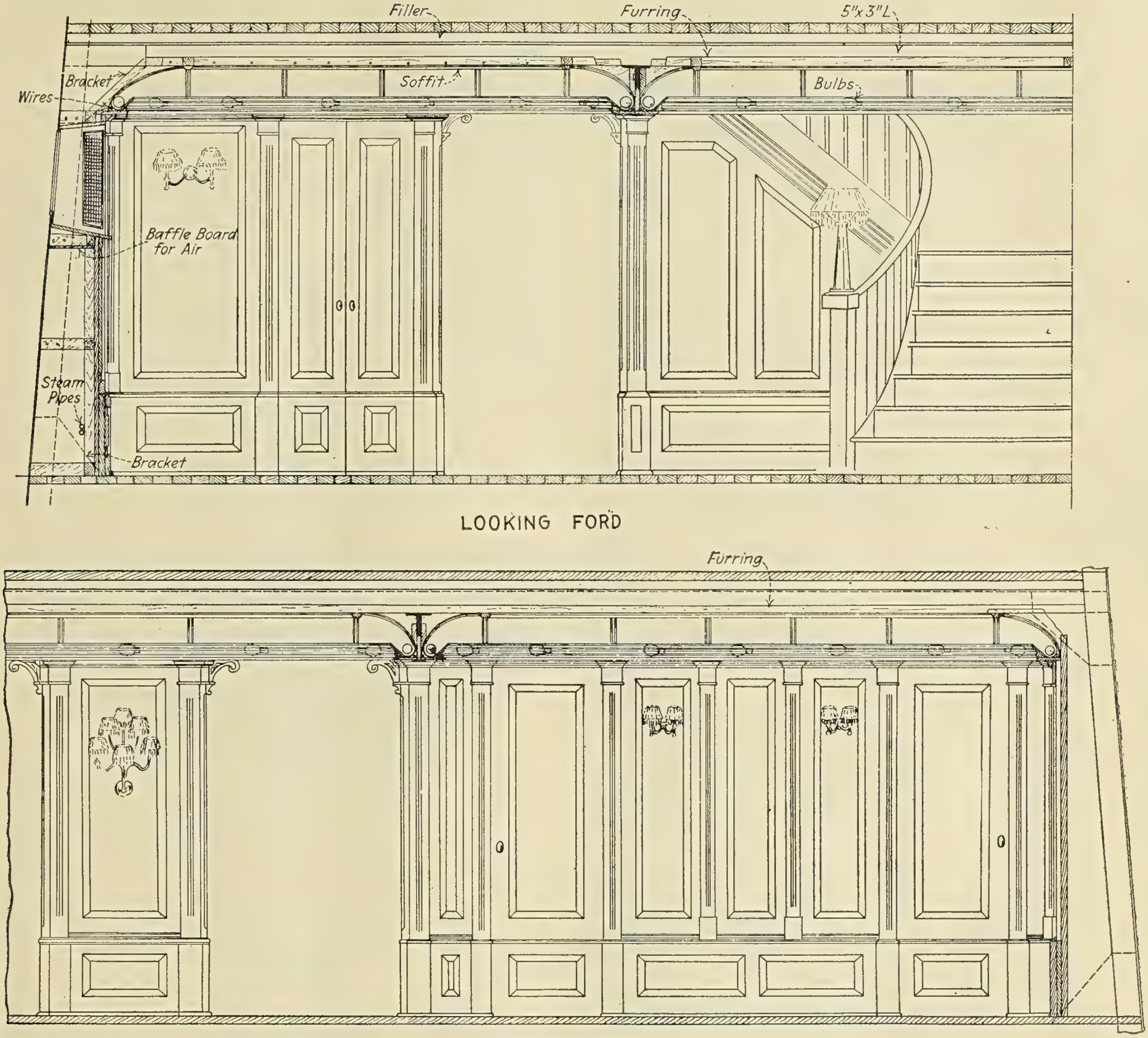


Fig. 20.—Dining Saloon: Joiner Details at Forward and After Ends

which meanwhile operates without its direct current field, thus electrically braking the motor and bringing the propeller approximately to rest. It then operates as an induction motor to start the propeller in the reverse direction, and finally as a synchronous motor.

The principal characteristics of the main propelling machinery are as follows:

A Worthington Pump & Machinery Company, New York, surface type condenser having a cooling surface of 7,000 square feet is installed, with a length over the covers of 14 feet 10 inches and a shell diameter of 6 feet 1½ inches.

The main condenser circulating pump motor, supplied by the General Electric Company, drives a Worthington centrifugal type pump. The motor rating is 230 volts, 94/187 amperes, 25/50 horsepower, 800/1,000 revolutions per minute, while the pump rating is 7,000 gallons per minute against a 16-foot head. The diameter of the suction is 20 inches and the diameter of the delivery pipe to the condenser is 16 inches.

A gravity, direct pressure, combined lubricating system of the Worthington-Blake-Knowles type is used. A single cylinder pump having a steam cylinder diameter of 6 inches, an oil cylinder diameter of 6 inches, and a stroke of 12 inches actuates this system.

Two multi-whirl type oil coolers were supplied by the Griscom-Russell Company of New York.

A DeLaval oil purifier, having a rating of 100 to 120 gallons per hour, is also installed.

The turbo generator set of the horizontal, high pressure, 8-stage, impulse, condensing type built by the General Electric Company has a rated horsepower of 3,350 and a speed of 3,000 revolutions per minute. Current is generated by the unit at 1,100 volts and 1,234 amperes. The generator rating is 2,350 kilowatts.

The main propelling motor is of the General Electric synchronous type with a rated horsepower of 3,000, running on alternating current of 50 cycles, 1,180 amperes, 1,150 volts and having a forced system of ventilation.

Two General Electric turbo generator sets of 150 kilowatts each are installed for excitation and lighting. Each unit consists of a 300-horsepower turbine running at 3,600 revolutions per minute, driving a 150-kilowatt generator through reduction gears made by the Poole Engineering and Machine Company, Baltimore, Md., at 1,200 revolutions per minute. The generators are rated at 600 amperes and 250 volts.

The main switchboard, supplied by the General Electric Company, contains one main control panel and three exciter panels with seven power circuits installed in the engine room.

A ½-kilowatt, 2,500 revolutions per minute motor generator set made by the Holtzer-Cabot Electric Company, Boston, Mass., has been fitted on the upper deck for supplying current to the wireless at 120 volts and 500 cycles. A spare steam driven lighting set is installed in the main engine room. This set consists of a 50-kilowatt, 3,600 revolutions per minute, 2-stage General Electric condensing turbine, driving a 4-pole, compound wound interpole machine at 3,600 revolutions per minute, which generates current at 400 amperes and 125 volts.

An emergency lighting set driven by a four cylinder gasoline engine built by the Universal Motor Company, Oshkosh, Wis., is located on the upper deck. The generator for this set is a 2-wire, 8-pole, compound wound machine, manufactured by Kurtz & Root, Appleton, Wis. The speed of the unit is 1,150 revolutions per minute. It generates current at 110 volts and 37 amperes.

Forced draft ventilation for the main motor is obtained by means of a squirrel cage type American "Sirocco" fan made by the American Blower Company, Troy, N. Y. The impeller of this fan is 12 inches and the outer diameter of the impeller 1 foot 8 inches. The fan is driven by a General Electric 12½-horsepower motor, running at a speed of 800 revolutions per minute with a voltage of 125 and an amperage of 875.

The capstan, supplied by the American Engineering Company, Philadelphia, Pa., is driven by a General Electric 20-horsepower, compound wound reversing motor, rated at 160 amperes, 115 volts, running at a speed of 1,150 revolutions per minute. An electric type deck winch is installed with spur gear drive. This winch was made by the American Engineering Company. This company also supplied a spur gear type anchor windlass provided with two gypsy heads for warping. This windlass is of sufficient capacity to handle the two 5,110-pound bower anchors and chains with which the ship is equipped.

An American Engineering Company steam and hand control steering gear is installed. The steam engine for the steering gear has two cylinders, each 7 inches in diameter and 7 inches stroke. A "Sirocco" centrifugal American Blower Company fan having a diameter of 3 feet 7 inches and a width of 2 feet 3 inches, with a steam cylinder 7 inches in diameter and 7 inches stroke is installed in the assisted draft system.

The auxiliary equipment includes:

A main condensate Worthington 2-stage hot well pump, driven by a 10-horsepower General Electric motor, running at 1,150 revolutions per minute.

Two 9 cubic feet capacity Worthington air ejectors with inter-cooler and after-cooler installed.

An auxiliary condenser of the Worthington type, having a cooling surface of 800 square feet, a length over covers of 13 feet 3 inches and a shell diameter of 30 inches.

An auxiliary circulating pump of the Worthington simplex horizontal type, having a steam cylinder diameter of 10 inches, a water cylinder diameter of 12 inches, and 12 inches stroke.

An auxiliary air pump of the Worthington simplex horizontal type, having a steam cylinder of 10 inches diameter, an air cylinder of 12 inches diameter, and a stroke of 12 inches; diameter of air duct is 5 inches at intake and at discharge 4 inches.

A main boiler feed pump of the Blakes-Knowles simplex vertical type, having cylinders 10 inches by 7 inches and a stroke of 24 inches, with a 4-inch suction and 3½-inch diameter discharge.

An auxiliary feed pump, also of the Blake-Knowles simplex vertical type, steam and water cylinders of 10 inches and 7 inches diameter and a stroke of 24 inches, a 4-inch suction and a 3½-inch discharge.

A bilge pump of the duplex horizontal type, made by the Epping-Carpenter Pump Company, Pittsburgh, Pa., having steam and water cylinders of 12 inches and 8½ inches diameter, and a stroke of 12 inches.

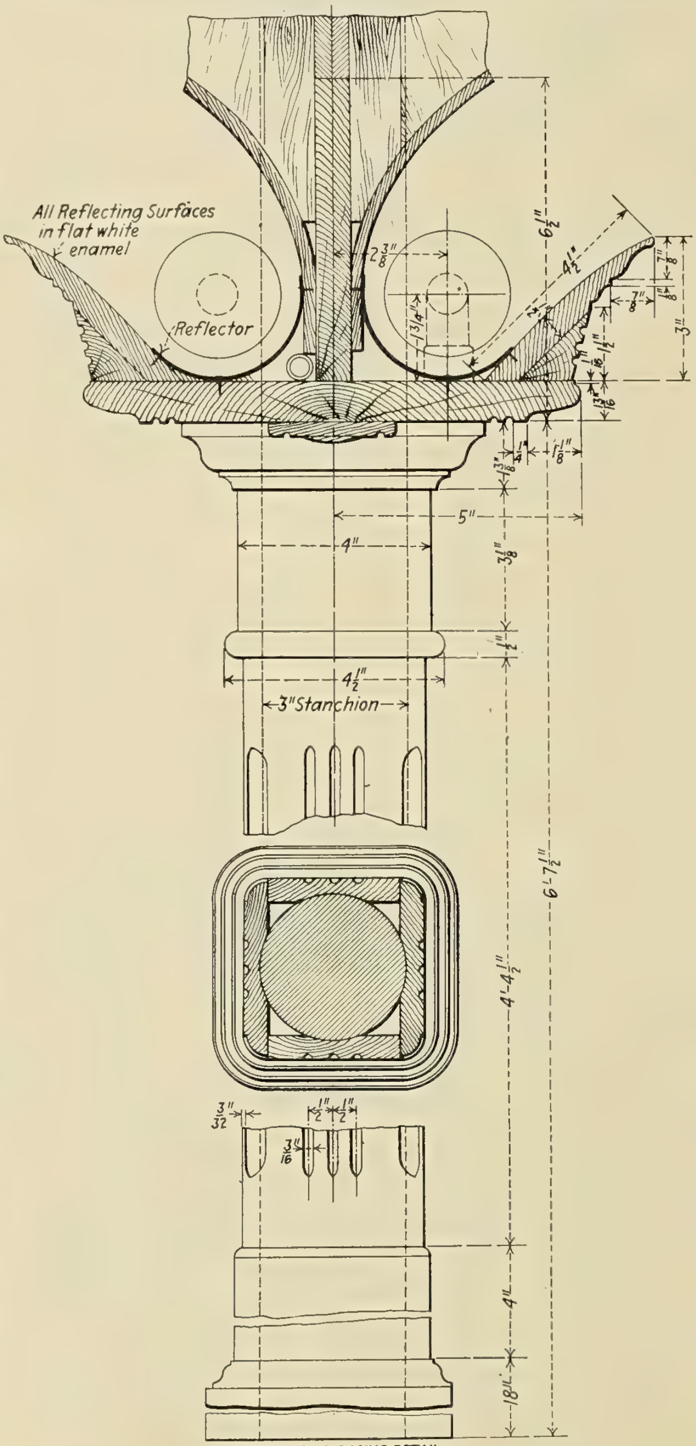
A sanitary pump of the Worthington duplex horizontal type, having steam and water cylinders 7½ inches by 7½ inches and a stroke of 6 inches.

A fresh water pump of the Blake-Knowles simplex horizontal type with steam and water cylinders 5½ inches by 5½ inches by 7 inches stroke.

An auxiliary bilge pump of the Worthington duplex horizontal type, having steam and water cylinders 6 inches by 5¾ inches and a stroke of 6 inches.

A fire pump of the Epping-Carpenter duplex horizontal type 12 inches by 8½ inches by 12 inches.

A feed water heater of the closed multi-whirl type made by



STANCHION CASING DETAIL

Fig. 21.—Detail of Stanchion Casing in Dining Saloon

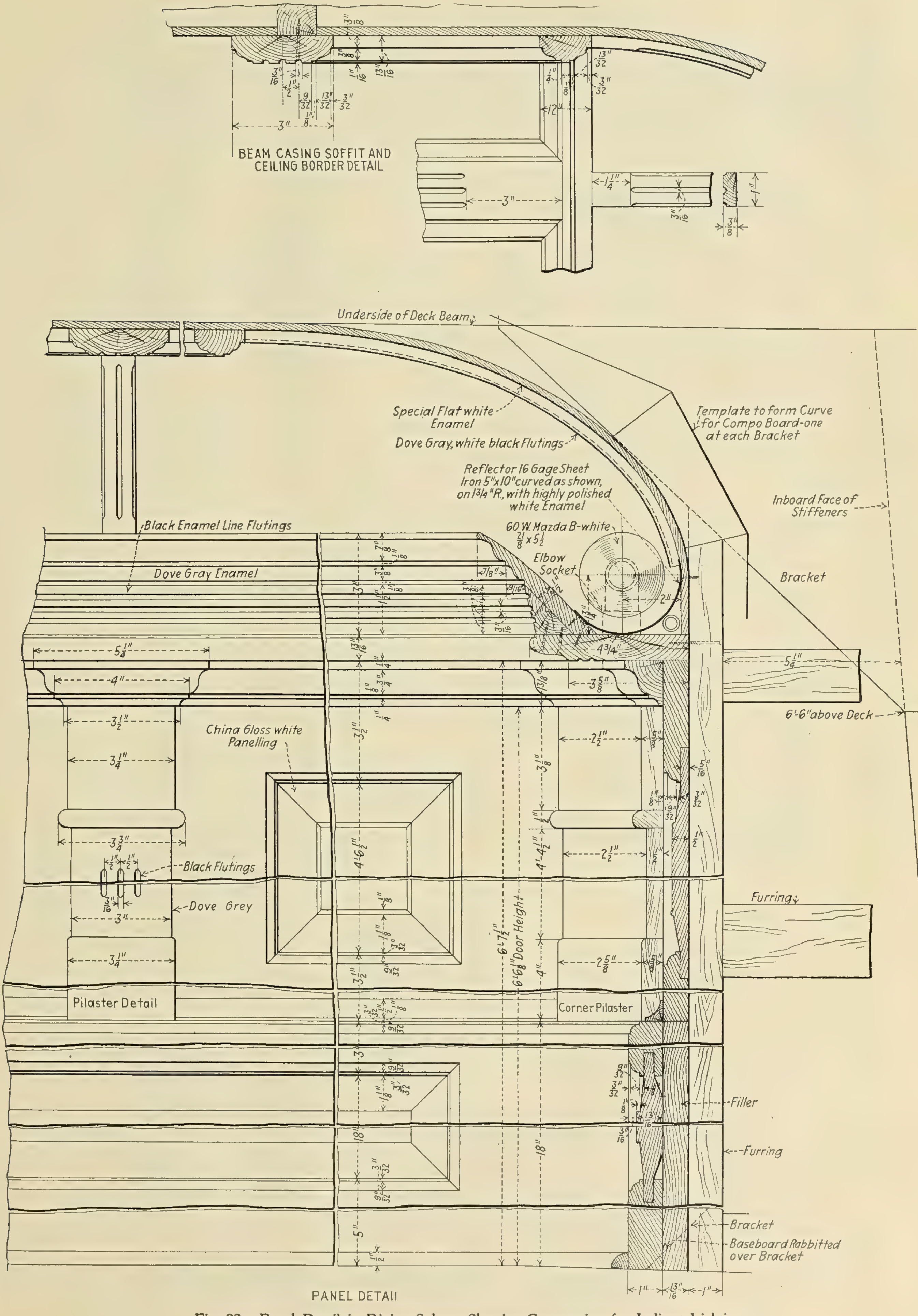


Fig. 22.—Panel Detail in Dining Saloon, Showing Construction for Indirect Lighting

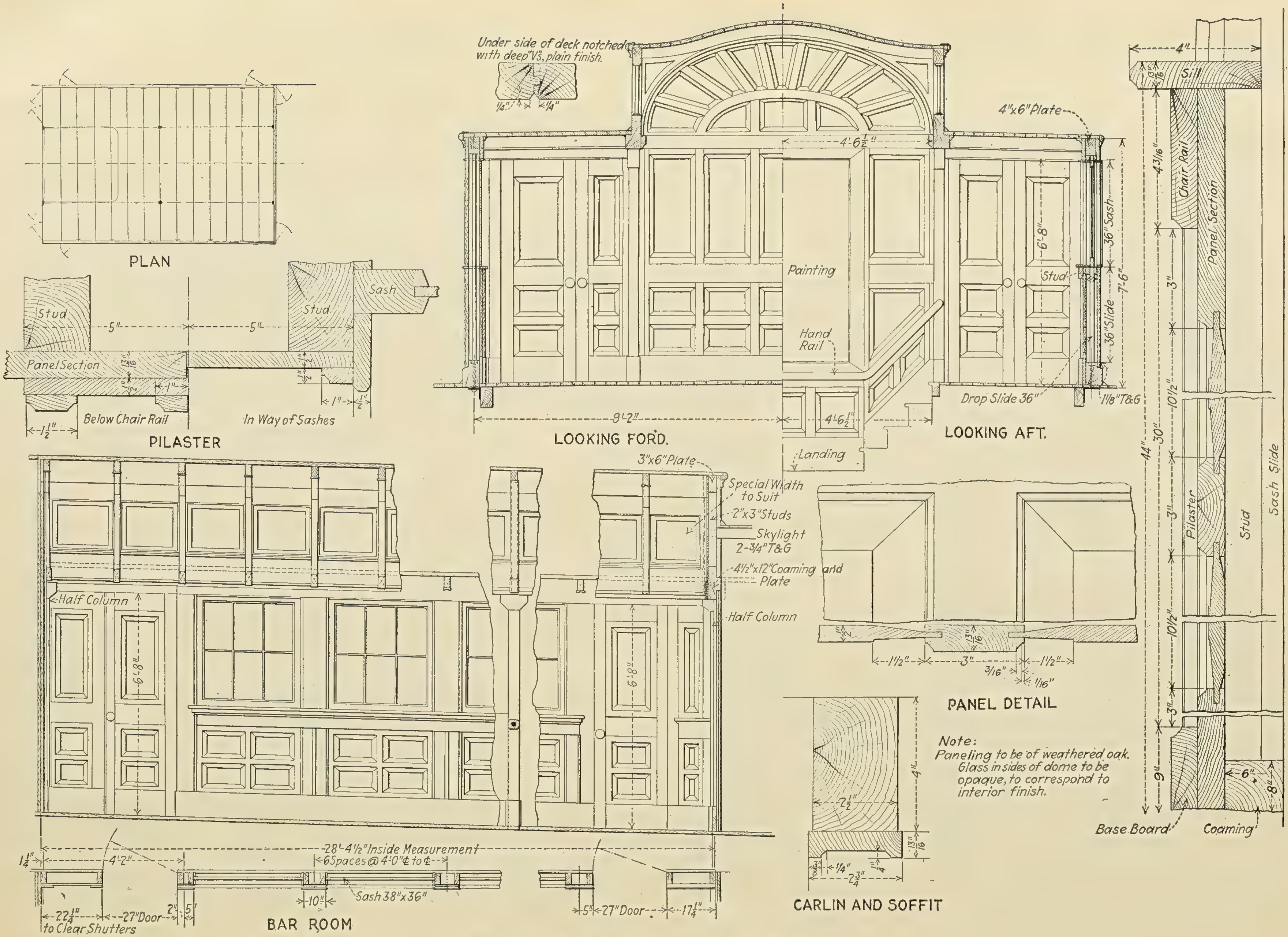


Fig. 23.—Joiner Work in Smoking Lounge and Bar Room

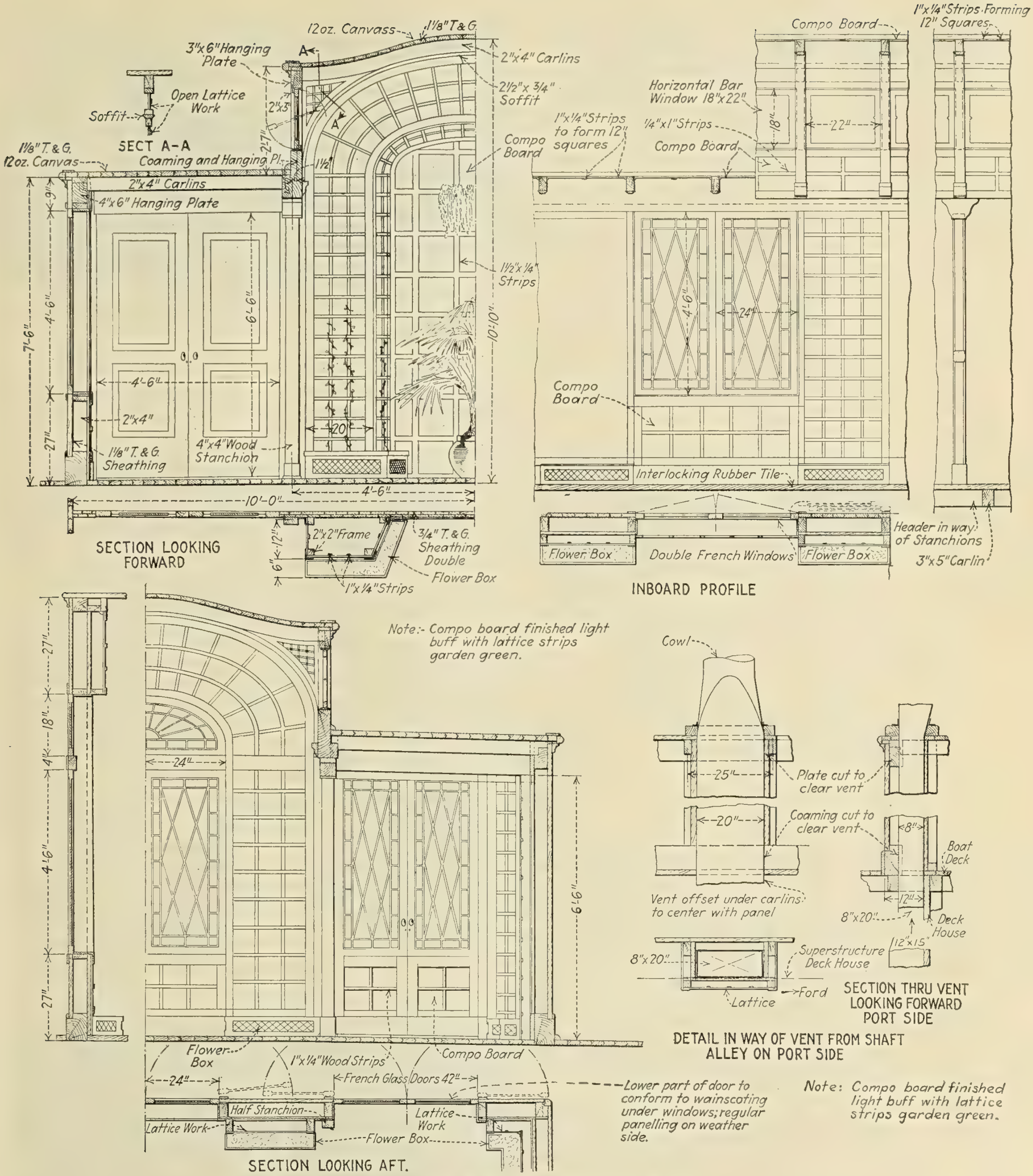


Fig. 24.—Details of Joiner Work in Veranda Café

the Griscom-Russell Company, of New York.

The vessel is supplied with a built-up type propeller with a cast iron hub and four manganese bronze blades. The characteristics of the wheel are as follows:

Diameter, 15 feet; pitch, 18 feet 9 inches; projected area, 52.32 square feet; developed area, 70.06 square feet; disk area, 176.71 square feet; projected area divided by disk area, 0.296; developed area divided by disk area, 0.396.

The propeller was supplied by the Columbian Bronze Corporation and was balanced to within two pounds. The blades are arranged for a variable pitch of 6 inches.

The lifeboats are of the American Balsa standard type and comprise two 20-foot metallic lifeboats, six 24-foot standard metallic lifeboats and two 24-foot Lundin boats.

The deck machinery has been supplied by the American Engineering Company, of Philadelphia, and comprises an electrical capstan, steam steering gear and anchor windlass, previously mentioned.

There is a deck winch fitted for taking care of the refrigerated cargo. This winch is electrically driven.

Two 8-ton Brunswick refrigerating machines are installed on the deck forward.

Cleaning Drain Pipes

DRAIN pipes on board ship often become plugged and great trouble is experienced in cleaning them. A pipe plug is generally fitted in the line for cleaning, as

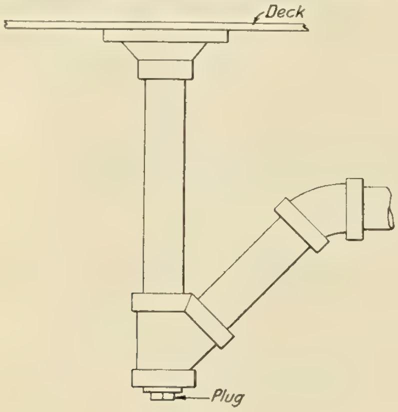


Fig. 1

shown in Fig. 1. In the majority of cases, however, it is in a cargo space or a bunker, and so impossible to get at.

The only thing to do in such a case is to insert a wire through the deck drain or use the fire hose with a nozzle and force the obstruction through. In the latter method it is necessary for one man to crawl into the drain and hold the nozzle, which has been wrapped carefully with packing

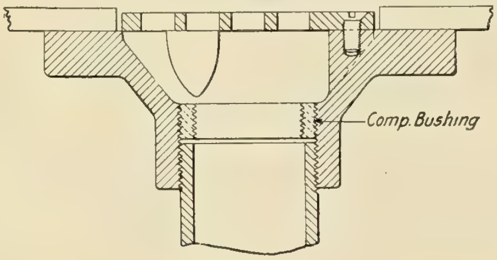


Fig. 2

to keep it tight, and for two others to tend the valve and the pump.

In the sketch, Fig. 2, is shown a cast iron body deck drain fitted with a composition bushing to keep the thread from rusting. A pipe nipple having a hose connection on one end may be screwed into the fitting and so connect the line directly to the fire main. M. V.

Welding a Fractured Rudder Frame

WHEN the 4,341-ton Green Star Line freighter *West Grama* was recently placed in dry dock for repairs at the Robins Dry Dock & Repair Company, South Brooklyn, N. Y., the frame of her 9-ton cast-steel rudder was found to be fractured in four places. The fractures all extended from 8 inches to 10 inches into the chunky side of the casting. To replace the rudder by purchasing a new casting would have cost $9,000, not including the cost of installing the renewal and the almost inestimable loss due to the idleness of the vessel while awaiting delivery of a new rudder, which would have taken about four months. It was therefore decided to repair the rudder frame by thermit welding.

In making this repair, the rudder was unshipped and laid on the dock with the frame in a horizontal position. The metal surrounding the four breaks was then cut out with an oxy-acetylene torch and chipped with a pneumatic chisel, so that four gaps, each about 3 inches in width, were made in order to provide space for the thermit steel later to enter, as shown in the illustration. The usual steps customary in thermit welding were then followed.

View of Two Breaks After Fracture Was Cut Out with Oxy-Acetylene Torch and Chipped with a Pneumatic Chisel

As the fractures in this particular repair extended only partly across the casting, it was necessary during preheating to offset contraction strains by heating the ribs at the ends of which the welds were located.

Each pair of welds was poured simultaneously, as the pattern wax had previously been shaped so as to connect the two gaps in each pair of welds. For the whole job 450 pounds of thermit in each of the two crucibles were used. The welds were completed within five working days after the fractures had been cut out and were reported to be satisfactory in every respect.

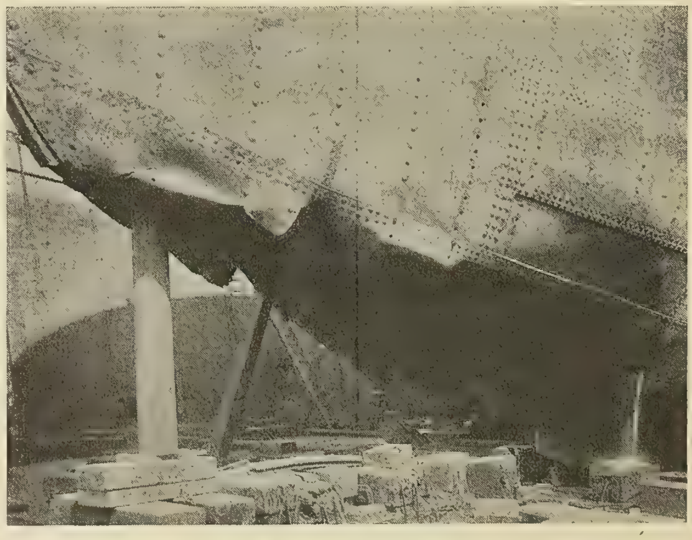
Repairs to the Willdomino

WHILE in the last leg of a voyage from Palermo and other Mediterranean ports to this side of the Atlantic, the *Willdomino,* a British vessel, having a length of 410 feet 6 inches, struck an uncharted rock off Canso, Nova Scotia. She was then towed to New York and drydocked at the Tietjen & Lang Dry Dock plant of the Todd Shipyards Corporation, Hoboken, N. J.

When the vessel was lifted out of the water it was found that the shell plating had been badly smashed from the bow aft to the forward collision bulkhead. This bulkhead was twisted as well, so that No. 1 hold had been flooded.

Although the plates were crumpled at the forefoot only, both the frames and the plating were badly twisted above the waterline and aft a distance of several stations. As a result, the entire bow had to be more or less reconstructed.

The work of fitting a new forefoot on the *Willdomino* is now nearing completion and the vessel will soon be ready for her return trip to the Mediterranean.



Damaged Forefoot of S.S. *Willdomino* Sustained by Striking Uncharted Rock Off Canso, Nova Scotia

Bolting-up in Ship Construction

Establishment of Standards and Introduction of Piece Work Result in Marked Savings in Construction

BY F. T. WARNER*

WITH the ending of the war and the main consideration of shipbuilders drawn from speed to economy, many improvements in methods were made. Articles in shipbuilders' journals would indicate that not every manager has taken even the first steps on some of the simplest improvements. For instance, the thought behind one recent article describing the success of spray painting in ship construction would seem to be that some shipyards might not have overcome the few obstacles in the way of this excellent scheme and that it was published for their benefit. It is therefore possible that one man's experience with that much more involved and important problem of bolting-up would be at least interesting, if not beneficial.

Importance of Bolting-Up

The importance of this phase of ship construction is known to most managers. In cost it represented during the war, in the large majority of American steel shipyards, from 15 percent to 25 percent of the cost of hull construction; bolting-up and riveting together from 30 percent to 45 percent of entire cost of hull construction.

The Standard Practice Bulletin No. 15 of the Emergency Fleet Corporation shows in Table 1 the actual number of employees engaged in several trades in seventeen shipyards during the war period. This table is useful in showing that the writer's experience is not unusual in regard to the ratio of number of men employed in one trade to that of another trade, it being assumed that cost ratio will approximate the ratio of number of men employed.

Not only during the war, but for some time after, thought and energy seemed to be centered in riveting. Records of riveting were everywhere published for the object of improvement, if not, in fact, to settle wagers or contests. Therefore, with little or no considerable thought given to the equally important trade of bolting, the average yard emerged from war conditions to find one of their biggest costs was without check or control.

Establishment of Standards

The first step in obtaining the necessary control was the establishment of a work unit and standard of quality. Past experience in pre-war times showed the lineal foot of single seam bolted to be satisfactory to start with. We had the berthing system and had eventually to adjust this unit to the berth, so looking ahead there was nothing to fear in this respect.

As to quality, each seam had to be tight enough so as not to enable a knife to get between the members bolted. The knife selected was the pallet knife such as is used by artists. The blade is about one-half inch in width, and when new something less than ten one-thousandths of an inch thick. These knives, however, were used until worn out, but all the bolting had to be "knife tested inside and out," regardless of the age of the knife. From this it will be seen that the bolter had only to put in such bolts as were necessary to meet the test. Knives were provided for all workmen as well as inspectors or supervisors and charged out of stores to them in the same manner as other tools.

Standards being thus established, returns each day were made on stationery printed for the purpose, showing number of feet bolted, cost per foot and location of work, etc. The ten ships each day that showed the highest cost of production were subjects of investigation.

Reorganization

At this stage it seemed advisable to make some changes in the organization, especially to get things started. Previously, bolters reported to ship foremen, who were principally men who had been the best ship fitters. A bolter foreman was named and rated as assistant hull superintendent and given responsibilities similar to those of the general foreman riveter.

Under the bolter foreman came quartermen bolters and leadingmen bolters on each ship. The quartermen, however, reported direct to ship foremen in regard to location of their work and in matters other than those which would tend to improve bolting production, for which the new foreman bolter was responsible.

Additional inspectors and counters were added and the daily production slips were signed by them in triplicate. The original went to the gang of bolters, the second to the foreman bolter and the third to the time office.

It will be seen that while the poorest bolters were being investigated, which resulted in increased production and better work, the ground work was being laid for a piece work system.

Introduction of Piece Work

At this time there were some few of the best men who had no scruples in regard to the stop watch, and we selected the very best of these men, who incidentally were the best in the yard, on whose work time studies were made. The results were very discouraging, as the cost of straight shell plating was over fifteen cents per foot for the first bolting and over this for changing bolts.

Many different bolting machines were also considered, but for regular bolting none was adopted.

After considerable study a simple classification was made and piece work prices set. These prices averaged less than 33 percent of the current costs at that time. With these prices went a guarantee of day's wages (at, of course, the Macy scale), in case the bolters did not earn over this on the piece work rates set. In other words, during the period of guarantee the bolters had nothing to lose but something to gain.

The thought behind this was that by the bolters only could corners be cut, and that if they tried hard to earn the piece work bonus they would eventually become expert and we would be enabled to set fair piece work prices. It might be well to state here that it has always been the policy of the management to consider as fair contract or piece work prices those averaging from 150 percent to 200 percent of the Macy wage, those lower being considered unfair to the workmen and those above too magnanimous. Also, in general, the management has been opposed to reducing piece work or contract rates, once established, except as the result of careful consideration and consultation with the workmen affected.

While with this first schedule it was not expected that workmen, except in most extraordinary cases, could earn bonuses, it was quite a surprise to find that in shop work they made exceptionally good and fairly so on certain ground assemble work. At that time plate shed punches not in use were fitted with dies for riveting and did good work. In this,

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as in work going to bull riveters, bolts needed to be put in at intervals averaging about three feet and the knife test was not required because these heavy machines brought the steel members together in a way which hand tools could not. In consequence of this, therefore, a reduction agreeable to the men was made.

During this period, and up until the guarantee of day wages was withdrawn, the ten gangs showing the poorest production were investigated. But after the first schedule had been prepared we priced each gang's work according to piece work prices and their work was no longer rated as the highest in cost, but as that on which the company lost money as determined by the difference in what we paid on day's wages and earnings at the piece work rates.

Second Schedule Introduced

After this first schedule of piece work prices was a second by which every good workman in shop and on ground and some few on the ship could earn from 150 percent to 200 percent of days' wages except in most unusual cases. The classification was also condensed into some twenty-five items and the day's wage guarantee was extended for two months.

At this stage regulators were found to be helping the bolters. The duty of the regulator was to adjust correctly the steel members placed in position by erectors who were required only to secure it with sufficient bolts to make safe.

There was no way of defining the extent and quality of the regulators' work, but as it was so necessary to good bolting we decided to include the cost with the bolting in the general control. From then on the bolter foreman was advised daily of his "cost per foot bolted," and this included the regulating cost. Regulators are paid days' wages in accordance with the Macy scale.

The work of the ship fitter is usually confined to lifted work or in cases of miscellaneous foundations, etc., that work which is taken direct from plans. In contracts made with fitters their work ended with the erection of lifted work or with final bolting-up in the case of small assemblies.

The bolters and regulators make ready for reaming. When unbolted holes are reamed the bolters change the bolts, clean out any burrs and chips between plates, and do all "laying up" required. The schedules covered prices for each operation and the feet bolted originally were about double that actually existing to be bolted by reason of these two operations on each foot. This second bolting is now being largely dispensed with by furnishing a single reamer with a rivet gang, who takes out bolts and reams the holes originally bolted as he goes along. He has assistance of riveters when needed and is paid piece work, at the Macy scale for reamers. From this it will be seen that where originally there were twice the number of feet bolted than actually existed, due to two operations, this is considerably reduced. At present, in over half the work no bolts are changed and there is no second bolting done. In fact, in one recent ship the entire shell has been taken after the first bolting by the riveters having with gang one man to ream. The reamers, using small drilling machines for reaming, do all the work alone, removing the bolts with the help of riveters at no extra charge to company.

Final Schedule Adopted

At the expiration of the two months' guarantee of day wages a third schedule of piece work prices was put into effect with no guarantee of day wages. Men who could not make the grade left the yard and were replaced by the best men from other yards which employed no piece work rates for bolting, the best men naturally wanting the piece work scheme.

Occasionally, when something unforeseen came up, "agreement prices" had to be made with the men, but each one was very carefully considered and when the work was finished the unit cost compared with the way the men worked. This became the basis of another piece work price which was added to the schedule or included under one of the classification items to which the price most nearly applied. After two months there was not an average of one agreement a week necessary. To be sure, in such a limited number of groups as we established and under the varying conditions the days' earnings were quite irregular, but the men were steady workers and evened things up in a week's run.

Personnel Improved

Ordinarily the personnel of the bolting organization is on a par with the labor personnel. Under the scheme adopted it is very much improved. The method of counting in company with the workmen themselves at which time the production and unit price are given on the slips to workmen tends to do away with protests because only those are considered which are due to errors in computations by the time keeping department, a very few indeed.

The bolter foreman, so necessary at first, made a change to his advantage when the plan was running smoothly and has not been replaced. The supervisory force has been reduced and this reduction now offsets the increased cost of counting and the closer inspection required by piece work. About 5 percent of the bolters work single handed, and by so doing get the prices usually paid a two-man gang. The earnings of the bolters are less than those of any trade in which the piece work rates were set by the Macy Board, but the men are satisfied with bonuses and conditions.

The management deals with workmen through a craft committee, the scheme in effect during the war. Open shop exists, and for the last eight months no difference between the company and workmen has existed which has not been adjusted by foremen without having come to the attention of the management of the company.

Results

An idea of the results obtained may be gained from the following cost, consisting of direct labor of all bolters and regulators, no leading men, as none is employed, and no indirect charges of any kind being included; the unit of production is the lineal foot of single seam bolted or rebolted:

January, 1920, cost per foot, 25 cents average.

August, 1920, cost per foot, 6 cents average.

While our cost in January might have been higher than the expenses of other shipyards, it is the opinion of the writer from many observations of the Atlantic shipyards that they were not. It should be noted that the costs are inclusive of the expense work done at the dry dock which cannot possibly in some cases be measured.

In this case the bolting is done by regulators at day-work wages and the cost is charged against other work that is measured.

Conclusion

In conclusion, a comparison of bolting cost to that of other properly controlled trades would further indicate the extent of the saving effected. The bolting cost is one-third of the riveting cost, and also less than fitting-up, ship carpentering, chipping and calking (including tank testing), all of which are well controlled as follows: Riveters 6 to 7½ cents per rivet; fitters and ship carpenters by contract work of known efficiency; chipping and calking by Macy scale piece work rates; and tank testers by contract and bonus.

The progress of development of this work would indicate that before another year has passed the cost of bolting should be less than 5 cents per foot and that 75 percent of the work would need no changing of bolts. Also, the plan, while at present being worked on several ships of a type, is easily applicable to any single steel ship that a yard may be called upon to build.

American Bureau Surveyors at Foreign Ports

IN accordance with the announced policy of extending its surveying facilities to all the principal seaports of the world where American ships are now trading in the extension of our foreign commerce, the American Bureau of Shipping, now the officially recognized classification society of the United States Government, is making careful analyses of port conditions and is assigning experienced surveyors as its representatives at such ports where the conditions warrant it. One of its vice-presidents is now engaged in visiting European countries and making recommendations based on the actual conditions found at each seaport. Already an exclusive surveyor has been detailed at Hamburg, who will have general supervision of the Bureau's interest at that and other important ports in the vicinity.

On November 6 Mr. Daniel Meyer sailed for Antwerp, where his headquarters will be located; from this point he will have general supervision of American classification duties in all ports of Belgium, and possibly Holland. Mr. George A. Browne will shortly sail for Havre and will be charged with looking after survey duties in northern France. Each of these gentlemen has had many years experience in shipbuilding and surveying, and each speaks the language of the country to which he is assigned. Exclusive surveyors have also been appointed recently at Havana, Rio de Janeiro and San Juan to act as surveyors at those ports. An official of the Bureau will shortly visit all ports in the West Indies, Central and South America to ascertain the conditions and necessities for surveyors at the principal ports where American ships will call.

The policy of the Bureau is to have none but American citizens as its exclusive representatives abroad. Each surveyor will be charged with the duty of doing everything possible to facilitate the surveying of American ships classed in the Bureau, and in a general way to aid in every legitimate way the extension of American commerce at the port where he is assigned. Wherever possible, the surveyors will be taken from the experienced corps in this country, preference being given to those who can speak the language of the country to which he is assigned.

The Bureau now has the services of an experienced corps of non-exclusive surveyors in all the leading ports throughout the world, by its alliances with the British Corporation, the Registro Navale Italiano and The Imperial Japanese Marine Corporation. It is contemplated that at the less important ports arrangements will be made whereby exclusive surveyors may be maintained to represent the four allied societies.

Diesel Motor Yacht for Vincent Astor

Description of 160-Foot Steel Sea-Going Yacht Designed by Cox and Stevens and Equipped with Winton Diesel Engines

A NEW Diesel motor yacht of unusual interest is under construction at the yard of Robert Jacob, City Island, New York, for Mr. Vincent Astor. The vessel, which is of the sea-going type, is being built from designs by Cox & Stevens, naval architects, New York. The principal dimensions of the hull are as follows:

Length overall	160 feet 8 inches
Beam, molded	25 feet 0 inches
Depth, molded	15 feet 0 inches
Draft	10 feet 0 inches

Quarters

The deck house contains a large dining saloon at the forward end with a galley and pantry directly aft. Abaft the engine enclosure a smoking room, 14 feet long by 12 feet wide, is provided on the port side and an entry from the main deck with stairs to the owner's room on the starboard side. Next in order is the living room, which is large and commodious, being 22 feet long by 18 feet wide. Both the living and smoking rooms are provided with open fireplaces and are lighted by large square windows, which are without sash to afford the maximum opening and are operated by a gear device on the inside. A passage on the starboard side affords access between the after rooms and the dining saloon, and also communicates with stairs to the pilot house. The extreme after end of the deck house is arranged as a veranda, enclosed except at the after end and reached from the living room through a vestibule on the starboard side, which also gives access to the guests' rooms below. The after deck, provided with the usual transom and awning, gives a clear deck space of over 22 feet. A pilot house and radio room are located on the boat deck, and forward of these is a fair-weather seating space.

The quarters on the berth deck aft consist of two large staterooms for the owner with two wardrobes and a bath room. Abaft these on the port side are one double and one single stateroom with bath between and one smaller stateroom, while on the starboard side is a large stateroom with bath and a maid's room, toilet and linen locker. A toilet and shower room is located at the extreme after end of the passage. The entire berth deck forward of the engine room is utilized as crew space. Directly under the dining saloon is the officers' mess room, with dumbwaiter to pantry and stairs to the deck on the port side; also the refrigerator and galley storeroom and rooms for the captain, engineers, mate and steward. The forward portion of the berth deck, in way of the raised forecastle, is elevated 4 feet above the after portion, and on this deck are rooms for oilers, cook and second steward, a forecastle for six men, toilets and showers. An entry in the center gives access to the deck above and laundry below.

Hull

The hull is designed with full, graceful lines conducive to moderate speed, seaworthiness being an essential feature. The stem rakes forward with an inverse curve, sharp cutwater and full round at the forecastle deck. The stern is of the modified steamship type with the rudder entirely below the waterline. A bulwark rises in an easy curve abreast the pilot house to meet the raised forecastle deck at the forward end of the deck house.

Somewhat heavier than is usual for a yacht of these dimensions, the shell plating ranges from 3/8-inch to 5/16-inch plate. The main deck, under wood, consists of 3/8-inch plate in way of the stringer and a 5-pound plate elsewhere. The floors are 3/8-inch and 5/16-inch plate, and the tank top 1/4-inch plate. The deck house is constructed of 1/4-inch and 3/16-inch plate. The frames and main deck beams are 4 1/2-inch by 3-inch by 7.7-pound angles spaced 21 inches. Reverse frames of 3-inch by 3-inch by 5.1-pound angles are

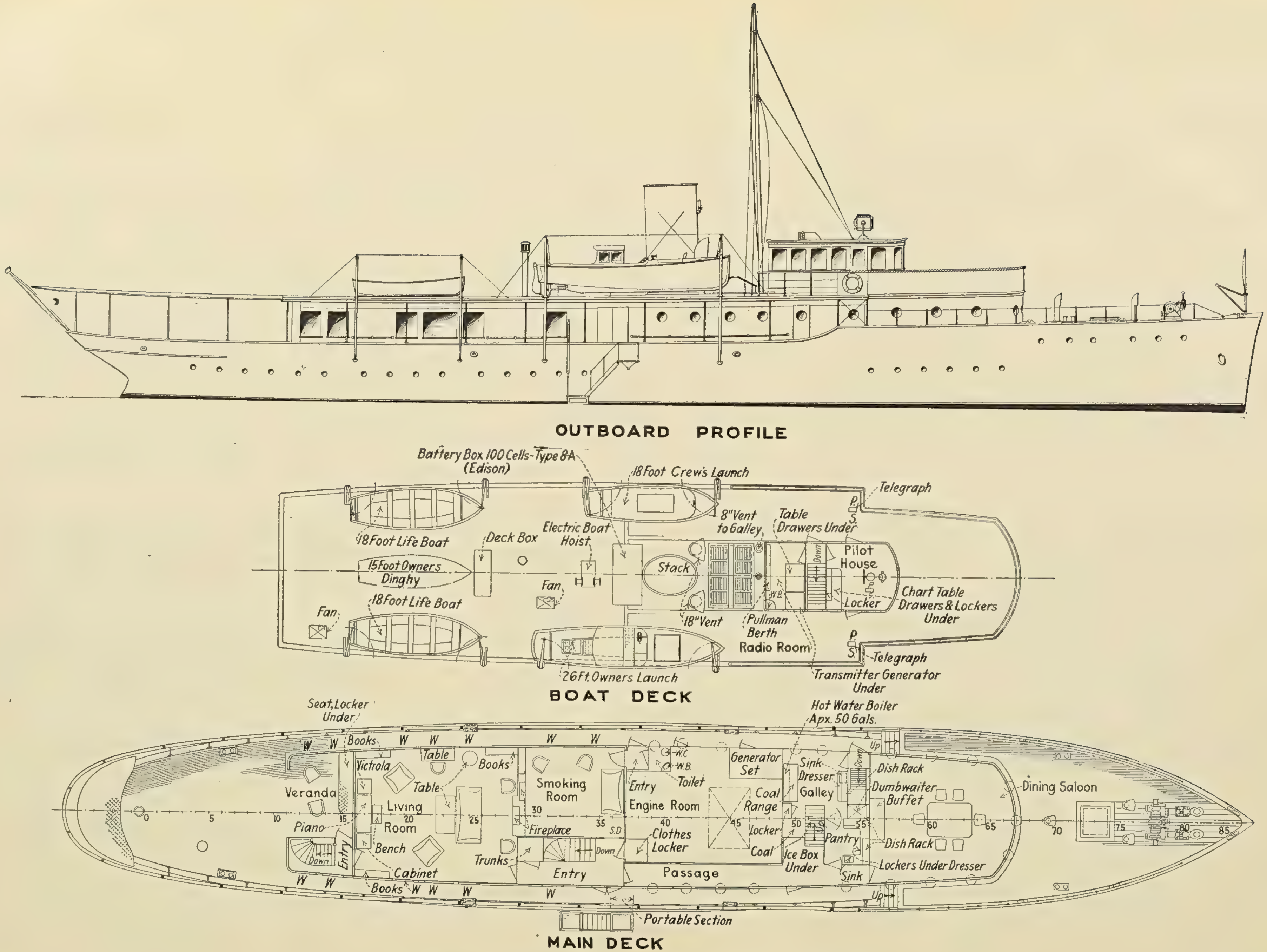


Fig. 1.—Outboard Profile and Weather Deck Plans of Astor Motor Yacht

DIESEL MOTOR YACHT FOR VINCENT ASTOR

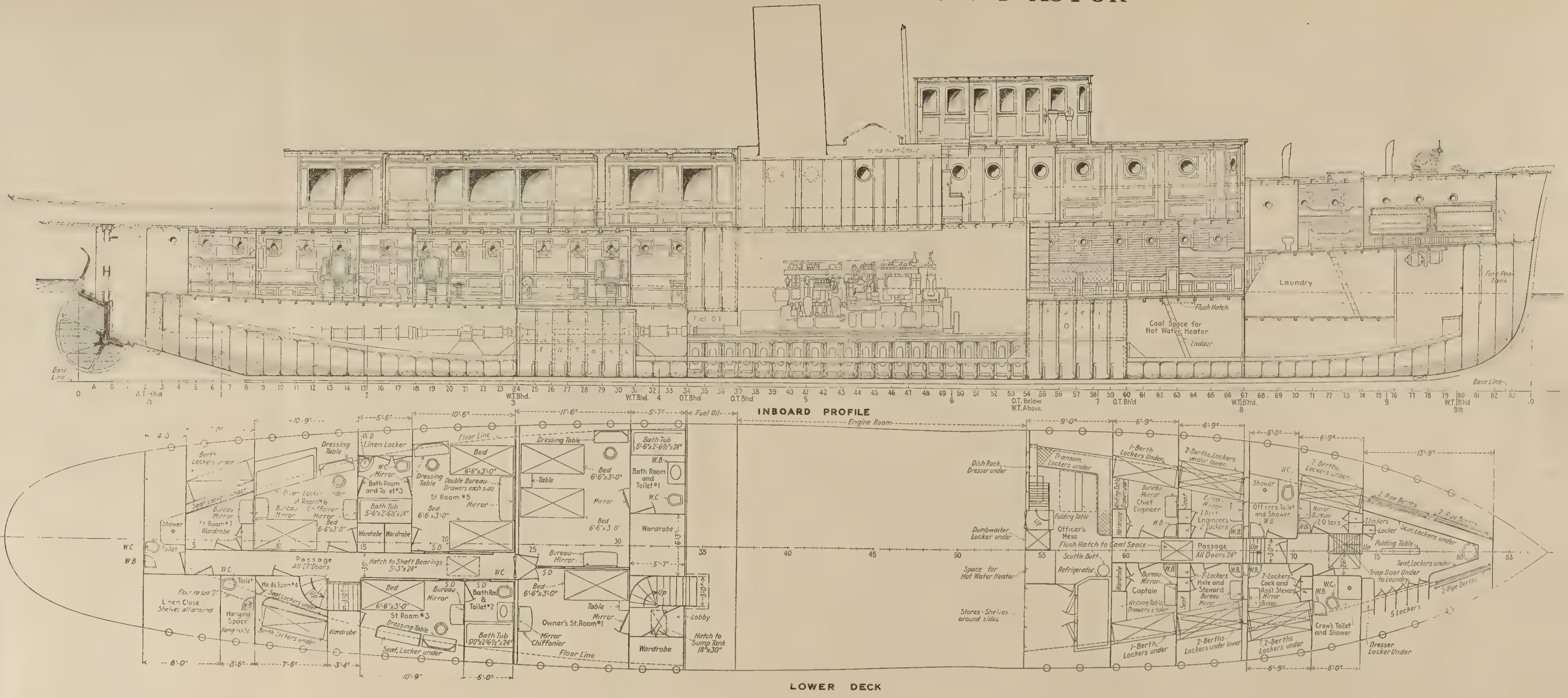


Fig. 2.—Inboard Profile and Lower Deck Plan; Length Overall, 160 Feet 8 Inches; Beam, Molded, 25 Feet; Depth, Molded, 15 Feet; Draft, 10 Feet; Horsepower, 700

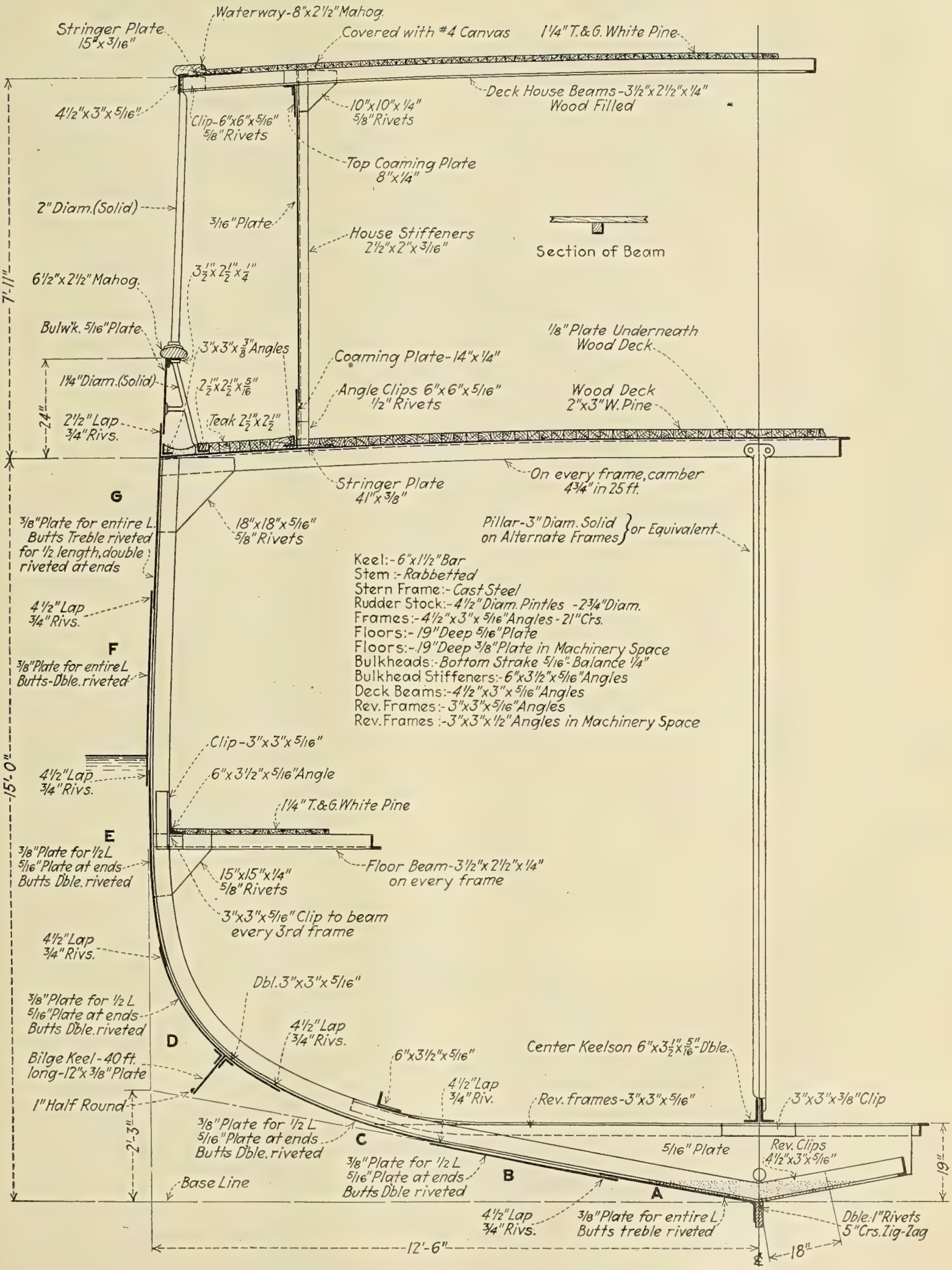
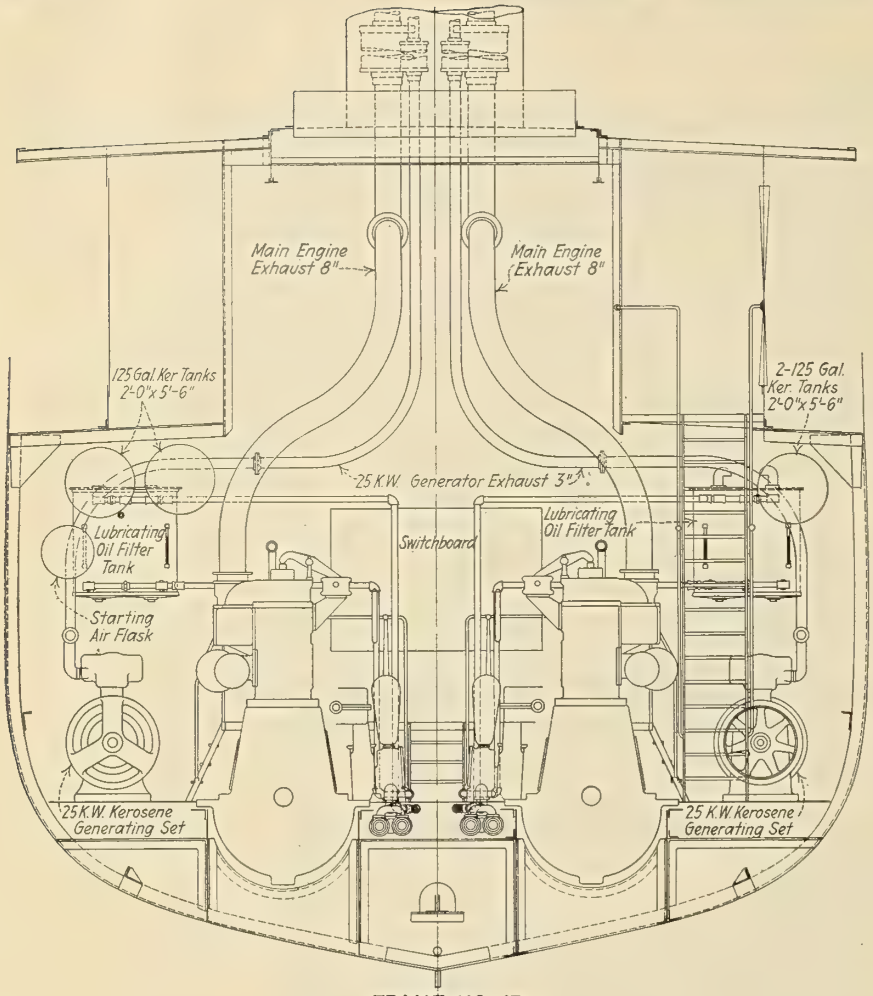
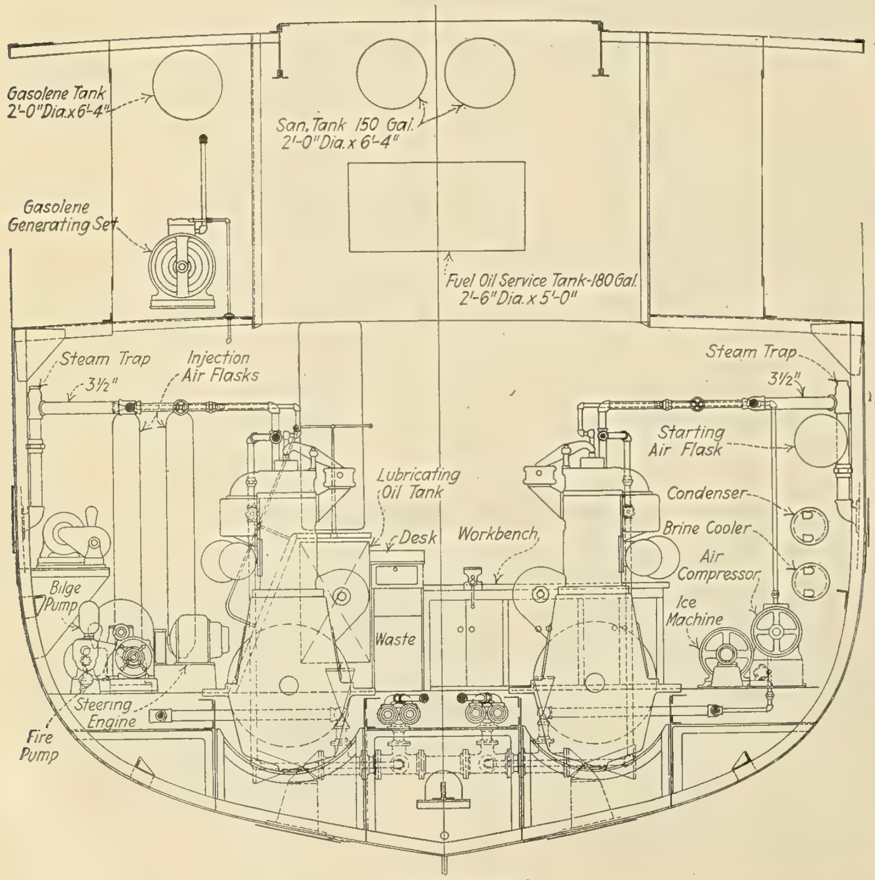


Fig. 3.—Midship Section 160-Foot Ocean-Going Motor Yacht



FRAME NO. 43
Looking Aft



FRAME NO. 47
Looking Ford

Fig. 4.—Sections Through Engine Room

fitted in way of the floors. Bilge stringers and center and side keelsons of 6-inch by 3½-inch by 9.8-pound angles are fitted and the house carlings are 3½-inch by 2½-inch by 4.9-pound angles.

There are seven full water and oiltight bulkheads of 5/16-inch and ¼-inch plating with 3-inch by 3-inch by 7.2-pound bounding angles and 6-inch by 3½-inch by 9.8-pound angle stiffeners. These bulkheads are located at the forepeak, break of forecastle deck, forward and after ends of engine room, after ends of oil tanks and water tank and the after peak.

The rudder is of the balanced type, built up of ¼-inch steel plates on a forged frame with a 5-inch stock.

The main deck is planked with 2½-inch by 2½-inch teak and the boat deck with 1½-inch white pine, canvas covered abaft the pilot house.

Main Propelling Machinery and Auxiliaries

The two main engines, located amidships, are of the full Diesel type, each with six cylinders 12 15/16-inch bore and 18-inch stroke, direct drive, with horseshoe thrust, made by the Winton Engine Works, of Cleveland, Ohio. The manufacturers' test cards show 350 brake horsepower at 250 revolutions per minute for each engine.

In the engine room are also located two 25-kilowatt General Electric Company, type GM-12, generating sets, 110 volts, direct connected to 4 cycle 4 cylinder kerosene engines 7¼ inches by 7½ inches with 560 revolutions per minute, in connection with which are 100 cells Edison A-8 batteries. This electrical equipment, together with a Winton 7½-kilowatt gasoline set installed in the upper engine room enclosure for emergency use, supply all the power for compressors, lighting, pumps and deck machinery.

Two Winton, model W-18, motor-driven air compressors for starting, whistle and charging air bottles used in conjunction with compressors, are attached to the main engines.

Pumps made by the Kinney Manufacturing Company are provided as follows.

Bilge pump—3-inch suction, 2½-inch discharge, 3-horsepower motor.
Fire pump—2½-inch suction, 2-inch discharge, 3-horsepower motor.
Fresh water pump—1½-inch suction, 1½-inch discharge, ¾-horsepower motor.
Salt water pump—1½-inch suction, 1½-inch discharge, ¾-horsepower motor.
Oil service pump—1-inch suction, 1-inch discharge, ⅓-horsepower motor.

All pumps are bronze except the oil pumps.

An electrical steering gear, manufactured by the Mead-Morrison Manufacturing Company, is to be installed with control in the pilot house and the motor and gear in the engine room. An emergency tiller is also provided.

In the engine room are also installed all

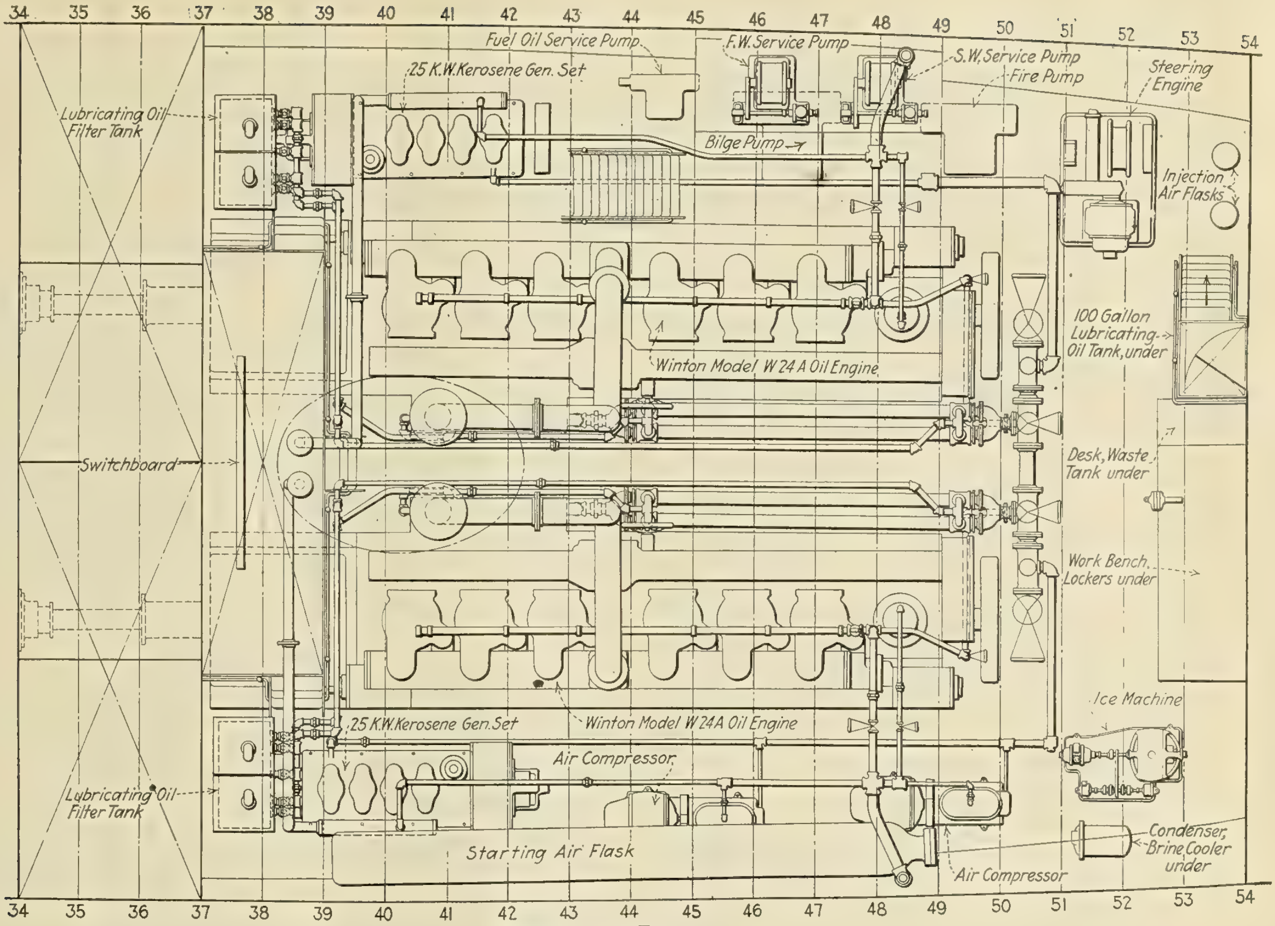


Fig. 5.—Plan of Engine Room

necessary air flasks, lubricating and kerosene oil tanks, switchboard, work bench and a one-ton ice machine supplied by the Clothel Manufacturing Company.

An electric windlass is mounted on the forecastle deck with its motor below the berth deck.

The small boats will be handled by an electric hoist on the boat deck abaft the stack.

The after quarters below deck are ventilated by two small motor-driven blowers located on the after boat deck with a supply duct system between partitions and under the floor.

The plumbing is supplied by the J. H. Curtiss Company. Fresh and salt water gravity tanks located in the fidley supply baths, lavatories and showers throughout the quarters. Sewage is conducted to a sump tank below the after berth deck and emptied by a motor-driven centrifugal pump.

Oil fuel is carried in a deep tank aft and a low tank forward, each divided into two separate compartments and having a total capacity of 67 long tons.

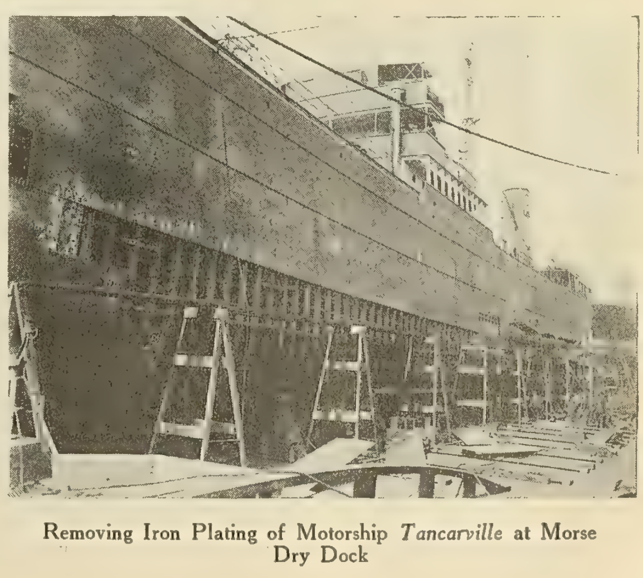
A fresh water tank of 30 long tons capacity is located under the after quarters.

Iron Vessel Overhauled at Morse Dry Dock

THE shipbuilding industry of today does not countenance the iron-plated ship, but such a craft has, despite the disadvantages in weight, etc., the properties of long life. An example of this type of vessel is found in the motorship *Tancarville,* which came to the Morse Dry Dock and Repair Company, Brooklyn, N. Y., for repairs recently.

While the ship had had its underbody tightened and renewed on previous occasions, it had not, in three decades, needed or received the thorough overhauling it underwent at the Morse plant. Its hull was completely reconditioned, new plates being put on where needed and other plates made watertight.

The *Tancarville's* history has been an interesting one. Originally a steamship, the vessel at one time was sunk off the coast of Siam by a boiler explosion. She was salvaged and completely fitted out in Hong Kong. Since her rehabilitation she has been converted into a motorship, being fitted with two motors of 500 horsepower each. These are said to be giving excellent service and an average speed of seven knots.



Removing Iron Plating of Motorship *Tancarville* at Morse Dry Dock

New 20,000-Ton Tankers*

Standard Oil Tankers Designed and Built by the Newport News Shipbuilding and Dry Dock Company

BY H. F. NORTON

THE vessels designed by the Newport News Shipbuilding and Dry Dock Company for the Standard Oil Company of New Jersey will be of interest on account of being, so far as we are aware, the largest tankers yet built and because of several unique features in design, especially in connection with the structural work.

They are two twin screw ships 550 feet between perpendiculars, 75 feet beam, 43 feet 3 inches depth to shelter deck and about 20,300 tons deadweight on a draft of 30 feet. The vessels are designed with straight stem and elliptical stern and rigged with three pole masts. They are of the shelter deck type with complete steel shelter and upper decks, except that the upper deck is omitted in the expansion trunk in way of the oil tanks. The vessels are being built under the special survey of the American Bureau of Shipping to the highest class.

Propelling Machinery

The propelling machinery is located in the stern and consists of two triple expansion engines set side by side in the same engine room. The engines are designed for 3,800 indicated horsepower total at 200 pounds working boiler pressure and a piston speed of 585 feet per minute. The cylinders are 23-inch, 39-inch and 68-inch diameter respectively with a 45-inch stroke. The high pressure and intermediate pressure valves are of the piston type and the low pressure valve is flat and double ported. The crank and thrust shafts are 13 inches in diameter, the line shafts 12½ inches and the propeller shafts 14½ inches.

One condenser is fitted outboard of each engine, with an attached air pump on each engine and attached bilge and sanitary pumps on the starboard engine only. The starting platform is at the level of the top of the engine bed plates and located between the two engines. There are two centrifugal circulating pumps with engines. The propellers are to turn outboard, one a left hand and one a right hand screw, each with cast iron hub and three manganese bronze blades.

Boilers

There are three single-ended Scotch boilers placed side by side with their backs toward the engines and fired from the forward end. They are four furnace boilers 17 feet inside diameter by 12 feet long and designed for 200 pounds steam pressure. So far as we are aware, these are the largest Scotch boilers yet built in this country except those for three ships for the same owners built by the Harlan and Hollingsworth Company in 1916, each of which had two boilers 18 feet in diameter by 11 feet 7 inches long and which are said to have given excellent service. There is also cylindrical two furnace, single ended, return tube donkey boiler 10 feet 11 inches in diameter by 10 feet 10½ inches long. The main boilers are fitted for burning oil only and the donkey boiler for coal only.

Fuel System

The fuel system consists of two horizontal duplex pumps 6 inches by 4 inches by 6 inches and two similar transfer pumps 14 inches by 9 inches by 12 inches. Three heaters are arranged so that oil may be discharged through them in multiple. The service pumps and their fittings are located in a gas tight steel enclosure on the port side of the boiler room. The transfer pumps are located, one in the fireroom and one in a special steel pump room enclosure in the after end of the fore hold. The after pump has a 6-inch connection to the after fuel oil tank and a 6-inch discharge connection to the 6-inch fore and aft transfer line to the forward fuel oil tank and transfer pump and also a 6-inch discharge connection on the shelter deck. The forward pump has a 6-inch suction to the forward fuel oil tank and a 6-inch discharge to the transfer line and to the shelter deck.

Auxiliaries

There are two main feed pumps 14 inches by 9 inches by 24 inches with brass water ends and automatic control gear, each to draw from the main feed tanks and reserve feed tanks and discharge through the feed heater or by-pass to the main and auxiliary checks on the main and donkey boilers. An auxiliary feed pump of the same size is fitted. There are also two injectors connected to the feed lines. There is an independent bilge pump, an engine room ballast pump, a forward ballast pump, an independent sanitary pump, a donkey boiler feed pump, a fresh water pump and an evaporator feed pump.

Besides the above auxiliaries there are two evaporators capable of producing 35 tons of fresh water each 24 hours and a distiller for 2,000 gallons a day.

Electric Plant

The main electric plant consists of two 20-kilowatt generating sets in the engine room and there is also an emergency generating set of 12½ kilowatts capacity driven by a gasoline-kerosene engine located on the upper deck forward. This set is also connected to the radio set so as to provide for the lighting of the ship and sending of wireless messages even though the main engine room may be flooded or on fire.

Refrigerating Plant

The refrigerating plant consists of a 2-ton ammonia machine fitted in a gas tight compartment in the engine room.

Engineers' Workshop

There is an engineers' workshop adjacent to the engine room equipped with a 14-inch screw cutting engine lathe about 6 feet between centers, a 20-inch drill press and a 12-inch double emery grinder, all driven from a countershaft connected with a 5-horsepower motor.

Cargo Oil Pump Room

The cargo oil pump room is located amidships and fitted with four horizontal duplex main pumps with compound steam cylinders 12-inch and 18-inch diameters and 24-inch stroke and oil cylinders 14½-inch diameter. These pumps are arranged to work with the ship's steam at 180 pounds or shore steam at 70 pounds, having a by-pass connection admitting live steam to the low pressure cylinder when working with low pressure steam. There are also two auxiliary vertical duplex pumps 12 inches by 8 inches by 12 inches. The main cargo oil suction system consists of two lines of 14-inch

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November 11, 1920.

NEW 20,000-TON TANKERS

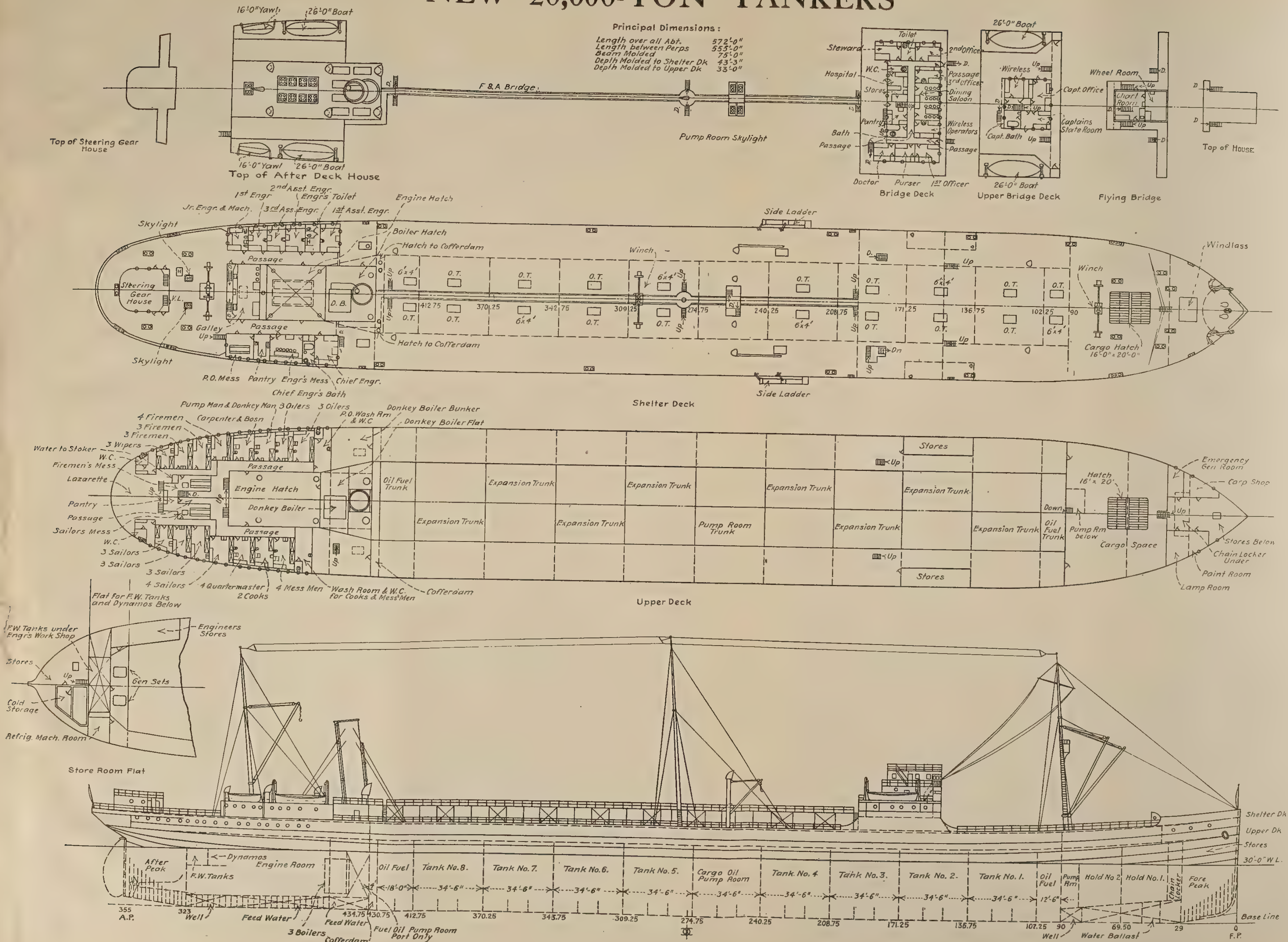
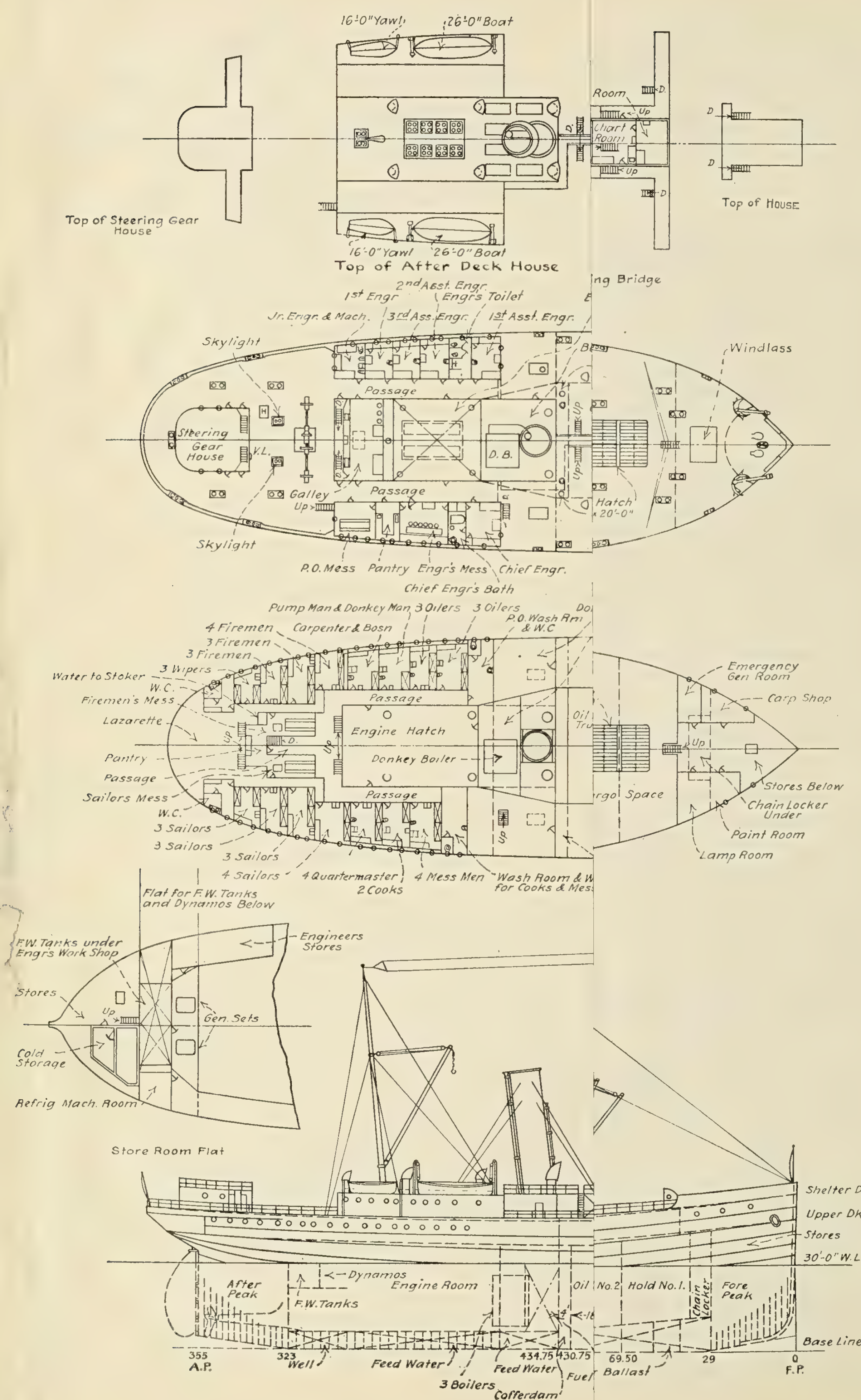


Fig. 1.—Profile and Deck Plans


16'-0" Yawl
26'-0" Boat
Room
Up
Chart Room
Up
D
D
D
D
Top of House
Top of Steering Gear House
16'-0" Yawl
26'-0" Boat
Top of After Deck House
ng Bridge
2nd Asst. Engr.
1st Engr
Engrs Toilet
Jr. Engr. & Mach.
3rd Ass. Engr.
1st Asst. Engr.
Skylight
Windlass
Passage
Steering Gear House
V.L.
D.B.
Galley
Up
Passage
Hatch 20'-0"
Skylight
P.O. Mess
Pantry
Engr's Mess
Chief Engr.
Chief Engr's Bath
Pump Man & Donkey Man
3 Oilers
3 Oilers
P.O. Wash Rm & W.C.
4 Firemen
Carpenter & Bosn
3 Firemen
3 Firemen
3 Wipers
Water to Stoker
W.C.
Firemen's Mess
Lazarette
Pantry
Passage
Sailors Mess
W.C.
3 Sailors
3 Sailors
3 Sailors
4 Sailors
Emergency Gen Room
Carp Shop
Passage
Engine Hatch
Donkey Boiler
Passage
Oil Tru
Up
rgo Space
Stores Below
Chain Locker Under
Paint Room
Lamp Room
4 Quartermaster
2 Cooks
4 Mess Men
Wash Room & W for Cooks & Mess
Flat for F.W. Tanks and Dynamos Below
F.W. Tanks under Engrs Work Shop
Engineers Stores
Stores
Up
Gen. Sets
Cold Storage
Refrig Mach. Room
Store Room Flat
Shelter Dk
Upper Dk
Stores
30'-0" W.L.
Dynamos
After Peak
Engine Room
F.W. Tanks
Oil
No. 2
Hold No. 1.
Chain Locker
Fore Peak
Base Line
355
A.P.
323
Well
Feed Water
3 Boilers
434.75
430.75
Feed Water
Cofferdam
Fuel
69.50
Ballast
29
0
F.P.

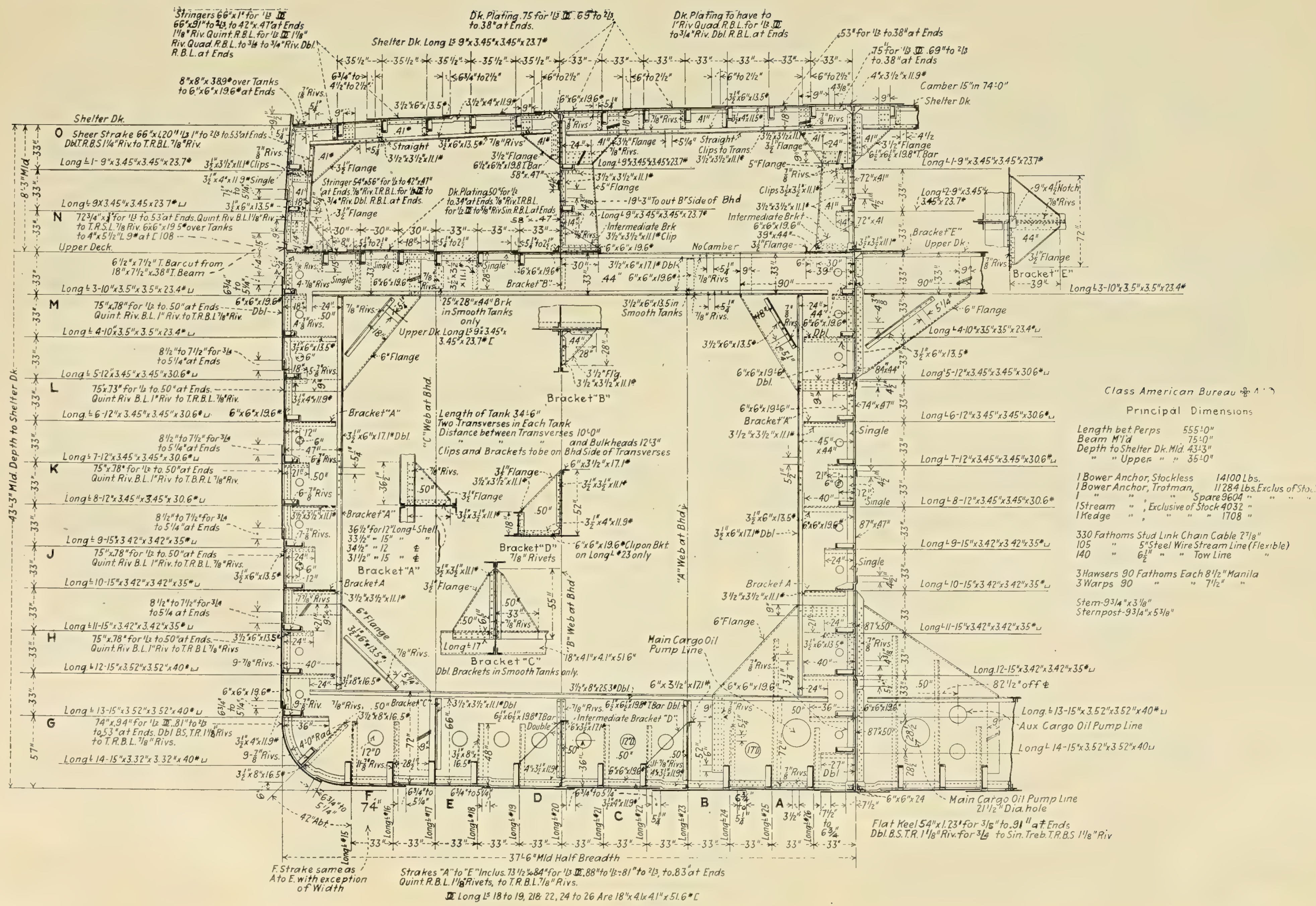


Fig. 2.—Midship Section

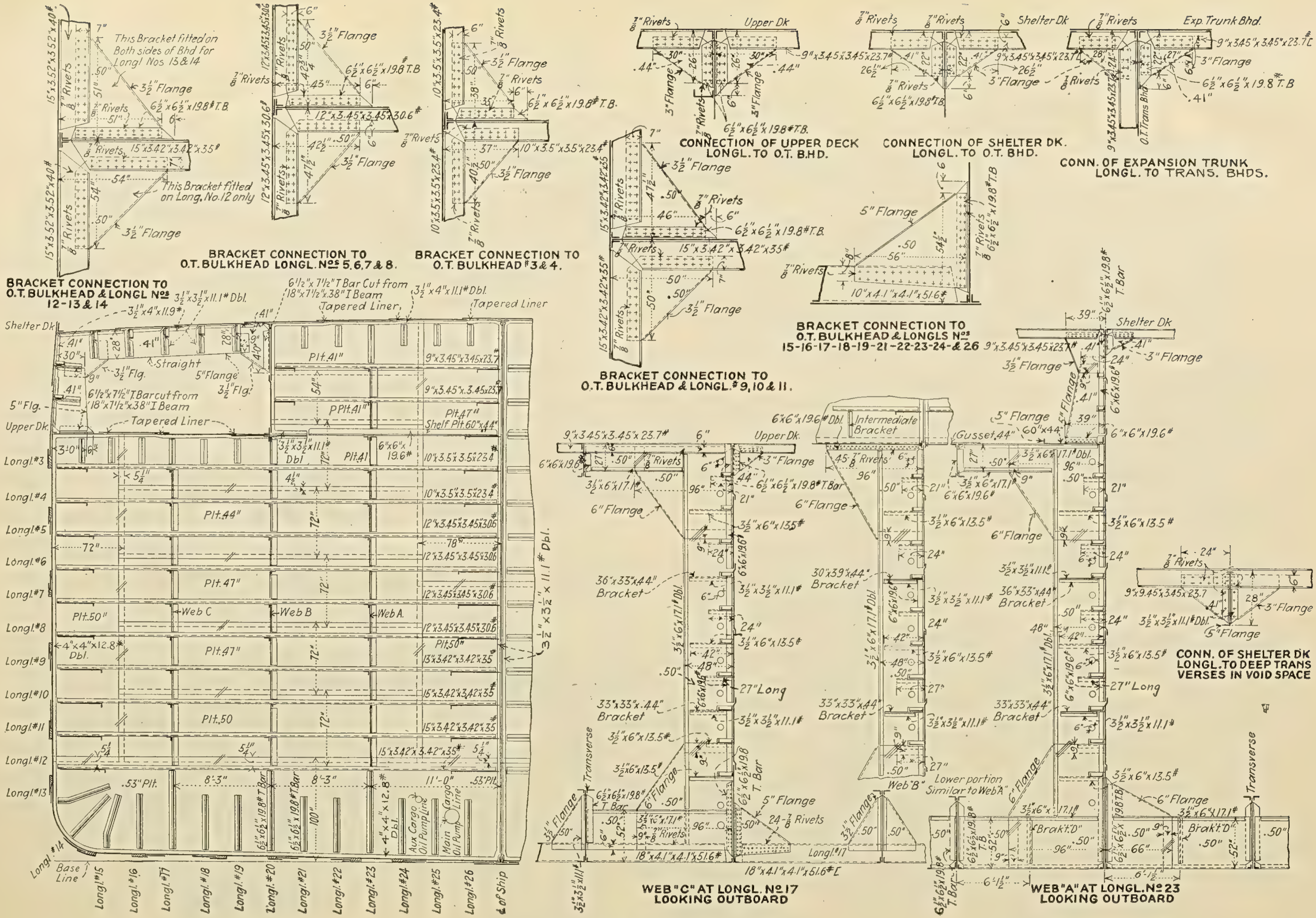


Fig. 3.—Details of Bulkhead Construction

pipes, one on each side of the centerline bulkhead for draining the after tanks and two similar lines leading forward for the forward tanks. Each main tank is connected to both main lines of piping by 10-inch valves and pipes. Cross connections are fitted in the pump room to enable any main pump to draw from any compartment on either side and discharge into any other compartment. There is also a 6-inch auxiliary suction line with a 4-inch suction branch fitted in each tank.

Most oil tankers are fitted with only two main cargo oil pumps. The above four large pumps are fitted on these vessels with the idea of being able to discharge the cargo with unusual rapidity. The 6-inch auxiliary suction line is fitted with the idea of being able to clean out the tanks after the large pumps have taken out the major portion of the oil. The size of the pumping equipment is evidence of the policy of the owners of obtaining the quickest possible turn around of the tankers in port.

There are four 12-inch discharge mains in the pump room connecting to a 12-inch main leading aft on the upper deck and to 12-inch cross mains on the shelter deck. There are also two 5-inch auxiliary discharges connecting to the by-pass of the main pumps. The discharge lines over the pump room are cross connected so that any of the pumps can discharge separately to either or both sides of the vessel. There are two 12-inch sea chests with stop valves fitted to the ship's sides in the pump room and connected to the pumps for ballasting the main cargo tanks.

Steam Heating System

Complete steam heating system and heating coils for the main cargo tanks and fuel oil tanks are provided, and also steam smothering pipes for fire extinguishing.

Hull

It will be noticed from the plans that there are eight main cargo oil tanks each 34 feet 6 inches long and that the cargo oil pump room is also the same length. This length of cargo oil tank is unusually great, but it will be noticed that the oil tight centerline bulkhead divides each main tank into spaces on each side of the vessel which are approximately square; that is, the half beam of the ship which is 37 feet 6 inches is a little more than the length of a main cargo oil tank. There are no summer tanks and the wing spaces outboard of the expansion trunk and between the upper and shelter decks are used for pipe passages only. This is due to the fact that the vessel is designed primarily to carry one kind of oil and the omission of the summer tanks results in a simpler construction and a distribution of the structural material where it is more efficient in contributing to the longitudinal strength of the vessel.

Gatewood System of Longitudinal Framing

The vessel is designed on the Gatewood system of longitudinal framing. The main framing consists of two deep transverse webs, ordinarily called transverses, fitted between each pair of main transverse bulkheads. The longitudinals are then worked continuously through these transverses and are cut and bracketed at the main transverse bulkheads. The Gatewood patented system of longitudinal framing takes advantage of the reinforcement of the longitudinals by the brackets at the bulkheads and so spaces the tranverses and designs the brackets as to make the maximum bending moments in the longitudinals as small as possible. At the same time some of the reaction load is taken from the transverses and transferred to the more rigid transverse bulkheads. Although the distance between the main transverse bulkheads is 34 feet 6 inches, the transverses are spaced only 10 feet apart, thus making each transverse a distance of 12 feet 3 inches from the adjacent bulkhead. This dimension is 2 feet 3 inches greater than the distance between transverses, but results in no greater bending moments on the longitudinals than occur at the transverses on account of the brackets which are fitted at the bulkheads. The other scantlings of the vessel in general are arranged about as usual for a 10-foot spacing between transverses and bulkheads, on a longitudinally framed vessel of the usual type.

The ordinary bottom longitudinals are 18-inch by 4.1-inch by 51.6-pound channels spaced 33 inches, which is wider than on any previous longitudinally framed vessel so far as we are aware. The side longitudinals gradually decrease in size to a 10-inch by 3.5-inch by 23.4-pound channel for the first longitudinal under the upper deck. The brackets connecting these longitudinals to the main transverse bulkheads are shown on the type plan of oiltight transverse bulkheads and the way the brackets gradually decrease in size to suit the size of longitudinals will be noted. The connections of the brackets to oiltight bulkheads are all by means of 6½-inch by 6½-inch by 19.8 pound T-bars with the standing flange double riveted to the brackets to provide the strongest possible connection and facilitate calking.

Bulkhead Stiffeners

The stiffening of the bulkheads is interesting on account of the unusual expanse of bulkhead to be supported. Deep bottom longitudinals are worked in way of the vertical webs *A* and *B* on the bulkhead and web *A* is provided with a bracket and girder to the transverses at the level of the upper deck to take the bending moment at this point. The arrangement of these brackets and girders at the upper deck level to take the stresses transmitted from the webs of the transverse bulkheads is interesting, as will be noticed on the plans. There is a horizontal web at the upper deck level to take the reaction of the vertical web *A* at that point and from the upper deck to the shelter deck in line with web *A* there is a small web designed to carry the load transmitted from the horizontal stiffeners in this location on the bulkhead. Web *C* is provided with a girder at the top and bottom to connect it with the transverses and take care of the bending moments in the brackets at the ends of the web. These moments on web *B* are cared for by its connection to the deep longitudinal at the bottom and to the expansion trunk bulkhead at the top.

Special transverse webs are provided in the wing spaces above the upper deck to provide support for the side and deck longitudinals in this vicinity. In order to provide as much longitudinal strength as possible, the side and deck longitudinals in this vicinity are worked continuously through all of the transverses with butts staggered.

The rough and smooth sides of the bulkheads alternate port and starboard in the main cargo tanks and on the centerline bulkhead through the main tanks, so that all the bulkheads may be tested and the smooth sides examined, after the ship is in service, by filling the minimum number of tanks. Both transverse bulkheads of the pump room are arranged to be smooth on the inside of the pump room so as to be readily examined at all times. In the same way all of the stiffening is kept inside of the fuel oil tanks at the ends, which will normally have oil in them.

Arrangement of Shell Plating

The sheer line of the vessel is straight and parallel to the base line for nearly the whole extent of the main cargo tanks. This fact, and the fact that the pump room is the same length as the main cargo tanks, permit a rather unique arrangement of the shell plating amidships. Each midship shell plate from the keel to the stringer is the same length between centers of butts, namely, 34 feet 6 inches, the length of the main cargo tanks. All the butts are arranged symmetrically with reference to the transverse bulkheads and the transverses, so that a number of plates amidships on each strake are exactly like each other in every respect. An exception to the above is that the plates of the bilge strakes *F* and *G* are made shorter for convenience in rolling for the turn of the bilge, but even these are symmetrically arranged so as to be like each other in sets of three.

Another point of interest is that, instead of arranging the clips on the transverses symmetrical with the midship section of the vessel as is usually done, they are arranged symmetrical with the adjacent transverse bulkheads in each case.

The straight sheer and the fact that the pump room is the same length as a main cargo tank result in a particularly symmetrical arrangement of the centerline bulkhead plating and also of the deck plating. Another interesting point on the deck plan is the small size of the hatches and the small number of them on account of the omission of the summer tanks.

Fuel Tanks

The main fuel oil tank is fitted at the after end of the main cargo oil tanks and a cofferdam worked between it and the boiler room. There is also a fuel oil tank fitted at the forward end of the main cargo oil tanks. The space between the forward fuel oil tank and the fore peak bulkhead is arranged as a hold space divided into two compartments by a watertight bulkhead to the upper deck level. There is a double bottom fitted under this space arranged to be used for water ballast. A double bottom for feed water is also fitted under the engine and boiler spaces. The forward peak tank is arranged for water ballast. The after peak tank is arranged for fresh water.

Accommodations for the captain, deck officers, etc., are provided in a double tier of steel deck houses amidship above the bridge deck. A wheel and chart house of teak is built on top of the upper house and a navigating bridge fitted at this level. Quarters for the engineers and those for the petty officers are located on the upper deck abreast the engine casing. The seamen and firemen have ample and commodious quarters in the after end of the upper deck, including the rather unusual feature of a separate pantry adjacent to the mess rooms.

A steel house is provided for the steering gear on the shelter deck aft and the top of this house fitted as a docking bridge.

Four 26-foot metallic lifeboats are provided, all under mechanical davits.

The vessels also have ample electric lighting arrangements, cold storage rooms, steam heating system, interior communication system, drainage system, fire main and deck service system, steam steering gear, steam windlass and winches. The plumbing arrangements are unusually complete for this type of vessel.

In fact, the size, outfitting and equipment of these vessels are such as to make them a notable addition to the already very notable fleet which has been built up under the supervision of D. T. Warden, manager of the foreign shipping department of the owners, the Standard Oil Company of New Jersey, and R. W. Morrell, their naval architect, who considers that these tankers, on account of their size and the simplified design made possible by adapting them to one trade only, will prove to be the most economical oil carriers yet produced.

Diesel-Electric Drive for Double Ended Ferry Boats and Low Powered Cargo Vessels

BY COMMANDER S. M. ROBINSON, U. S. N.*

THERE is a growing tendency to widen the field of the Diesel engine, but its lack of good maneuvering qualities has somewhat handicapped it in the marine field. It has been proposed to obviate this difficulty by the use of electricity. The objection to this method is that it apparently entails a loss of 13 percent in efficiency due to transmission losses. In the following article it is proposed to show that for double ended ferry boats and low powered cargo steamers this loss is entirely fictitious and that instead of a loss there is an actual small gain in efficiency due to the use of electricity for propulsion.

Double Ended Ferry Boats

In the July, 1920, issue of Marine Engineering there was an article entitled "Ferry Boat with Diesel Electric Drive" written by Mr. Renwick C. Dickie. In this article he mentioned the possibility of improvement in propulsion due to the possibility of operating the forward and after screws at different speeds.

With this type of boat there are four methods of propulsion that may be used:

(1) The two screws may be run at the same speed. This is the ordinary method where both screws are operated by one engine.

(2) The two screws may be run at slightly different speeds, so that each one will deliver the same effective horsepower.

(3) The forward screw can be allowed to run idle and, in this case, will act as a drag on the ship, all the power being delivered to the after screw.

(4) The after screw can be designed to deliver all the power needed to propel the ship, the forward screw being kept turning over at a speed just great enough to keep it from acting as a drag on the ship.

In regard to the third method of propulsion, it is believed that there would be very little, if any, gain over methods (1) and (2) on account of the very large increase in effective horsepower required for propulsion, due to the dragging screw. Experiments on the *Jupiter* and *New Mexico* indicate that this may be as high as 35 percent in the case of the ferry boat in question. This amount will vary considerably with the speed, and in some cases it is as low as 15 percent. In any case, however, this method cannot be as efficient as the fourth method, since in the fourth method the loss due to the forward screw is only about 4.5 percent, as will be seen later on. This, then, narrows us down to a comparison of methods (1), (2) and (4).

Analysis of Similar Ferry Boat

Before proceeding to a comparison of these three methods of propulsion for this ferry boat there is given an analysis of a similar double ended ferry boat in which the effective horsepower required to tow the hull had been determined by a model tank experiment. The actual horsepower and revolutions necessary to drive the ship at the given speed were then measured on actual trial, and from these data it is possible to determine the additional effective horsepower required due to the propeller race of the forward screw striking against the forward end of the boat.

These data have been analyzed, using the Dyson method

* Fleet engineer, Pacific Fleet, United States Navy.

TABLE 1.—FERRY BOAT HULL DATA

$LWL = 210$ feet. $B = 45.1$ feet. $H = 13$ feet. $\frac{B}{LWL} = .215$.
$N.B.C. = .578$.

After Screw	*Forward Screw*
$\frac{PA}{DA_4} = .432$	$\frac{PA}{DA_4} = .432$
$\frac{PA}{DA} = .324$	$\frac{PA}{DA} = .324$
$P = 9.55$ feet	$P = 9.55$ feet
$D = 10.5$ feet	$D = 10.5$ feet
$SBC = .76$	$SBC = 0$
$K = 1.36$	$K = 1$
$V = 19 = \frac{TS \times P \times (1-s)}{\pi D \times 101.33}$	$V = 16.14 = \frac{TS \times P \times (1-s)}{\pi D \times 101.33}$
$v = 12.73$	$v = 12.73$
$R_a = 147.9$ (actual trial)	$R_a = 147.9$ (actual trial)
$1 - s = .9135 = \frac{v \times 101.33}{P \times R_a}$	$1 - s = .9135 = \frac{v \times 101.33}{P \times R_a}$
$s = .0865$	$s = .0865$
$IHP = 3{,}830 = \frac{TS \times P \times IT_D \times D}{\pi \times 291.8}$	$IHP = 3{,}830 = \frac{TS \times P \times IT_D \times D}{\pi \times 291.8}$
$PC = .599$	$PC = .599$
$EHP = 2{,}293$	$EHP = 2{,}293$
$\frac{v}{V} = .67$	$\frac{v}{V} = .789$
$S = .069$.	$S = .21$
$v^y = 1{,}380$ (taken from Y Sheet 21)	$v^y = 2{,}043$ (taken from X Sheet 21)
$V^y = 6{,}500$ (taken from X Sheet 21)	$V^y = 4{,}093$ (taken from X Sheet 21)
(After) $IHP_a = \frac{.0865 \times 3{,}830 \times 1{,}380}{.069 \times 6{,}500} = 1{,}020$	(Forward) $IHP_a = \frac{.0865 \times 3{,}830 \times 2{,}043}{.21 \times 4{,}093} = 787$
(After) $IHP_p = \frac{1{,}020}{1.36} = 750$	(Forward) $IHP_p = \frac{787}{M_R} = \frac{787}{1.05} = 750$
$10^z = \frac{3{,}830}{750} = 5.105$	$10^z = 5.105$
$\frac{ehp}{EHP} = .209$	$\frac{ehp}{EHP} = .209$
$ehp = 479$	$ehp = 479$
(After) $PC = \frac{479}{1{,}020} = .47$	(Forward) PC (apparent) $= \frac{479}{787} = .609$
	(Forward) PC (actual) $= \frac{479 - 258}{787} = .281$

TABLE 1.—FERRY BOAT (*Continued*)

IHP_a (total) $= 1{,}020 + 787 = 1{,}807$.
IHP_a (actual) $= 1{,}845$.
Difference $= 38 =$ about 2 percent.
ehp (total) $= 479 + 479 = 958$.
ehp (due to ship resistance $= 700$.
Difference $= ehp$ due to propeller race from forward screw $= 258$, or 37 percent of the ship's resistance.

of analysis, and the result is given in Table 1. It will be noted that the calculated indicated horsepower is 1,807, while that actually measured on the trial was 1,845, or a difference of about 2 percent, which checks the correctness of the method. From these data it will be seen that the increase of effective horsepower due to the propeller race of the forward screw is 258, or 37 percent of the effective horsepower due to the hull resistance. This increase of effective horsepower will vary with the type of hull used, but as the two vessels under consideration are both double ended ferry boats it may be assumed that the percentage of increase will be about the same for both.

TABLE 2.—ELECTRIC DRIVEN FERRY BOAT

D	10	10	10
$\frac{ehp}{EHP}$	.2	.3	.4
ehp	340	340	340
$EHP = ehp \div \frac{ehp}{EHP}$	1,700	1,133	850
v	10	10	10
$\frac{v}{V}$	.57	.64	.69
$V = v \div \frac{v}{V}$	17.54	15.62	14.5
C	2.88	2.88	2.88
D^2	100	100	100
$\frac{PA}{DA} \times ET_P = \frac{EHP \times C}{D^2 \times V}$	2.79	2.09	1.687
SBC	.7	.7	.7
$\frac{PA}{DA}$	.31	.248	.22
PC	.677	.704	.708
$IHP = \frac{EHP}{PC}$	2,510	1,610	1,200
10^z	5.344	3.504	2.597
$IHP_p = IHP \div 10^z$	470	460	462
K	1.225	1.225	1.225
$IHP_a = IHP_p \times K$	576	564	566
V_1	19.746	15.852	13.787
$P = (D \times V) \div V_1$	8.89	9.85	10.5
S	.081	.077	.076
V^y	4,365	3,310	2,400
v^y	871	871	871
$s = \frac{S \times IHP_a \times V^y}{IHP \times v^y}$	.0932	.103	.099
$1 - s$	.9068	.897	.901
$R_a = \frac{v \times 101.33}{P(1-s)}$	120.5	114.7	107.2

TABLE 3.—FERRY BOAT (ELECTRIC DRIVE). HULL DATA

$LWL = 191.$ $B = 44.$ $H = 13.$ $\frac{B}{LWL} = .23.$ $N.B.C. = .4.$

After Screw	*Forward Screw*
$\frac{PA}{DA} = .248$	$\frac{PA}{DA} = .248$
$P = 9.85$	$P = 9.85$
$D = 10$	$D = 10$
$SBC = .7$	$SBC = 0$
$K = 1.225$	$K = 1$
$S = .077$	$S = .205$
$V = 15.6$	$V = 13.45$
$\frac{v}{V} = .641$	$\frac{v}{V} = .744$
$IHP = 1,610$	$IHP = 1,610$
$PC = .704$	$PC = .704$
$EHP = 1,133$	$EHP = 1,133$
$ehp = 340$	$ehp = 340$
$\frac{ehp}{EHP} = .300$	$\frac{ehp}{EHP} = .300$
$10^z = 3.504$	$10^z = 3.504$
$IHP_p = 460$	$IHP_p = 460$
$IHP_d = 564 = 460 \times 1.225$	$IHP_d = 460$
$V^y = 3,310$ (taken between X and Y Sheet 21)	$V^y = 2,410$
$v^y = 871$ (taken from Y Sheet 21)	$v^y = 1,000$
$s = .103$	$s = .142$
$1 - s = .897$	$1 - s = .858$
$R_d = 114.7$	$R_d = 119.8$

IHP_d (total) $= 564 + 460 = 1,024.$
ehp (total) $= 680.$

$$ehp \text{ (due to ship alone)} = \frac{680}{1.37} = 496.$$

The increase of 37 percent in effective horsepower will therefore be used in comparing method of propulsion (4) with methods (1) and (2).

Comparison of Methods (1) and (2)

The ferry boat proposed by Mr. Dickie was to be driven by two screws, one at each end of the ship, each being driven by an electric motor. Power was to be supplied by two Diesel driven generators of about 500 horsepower each. The data given for the hull were not entirely complete, so it has been necessary to make certain assumptions to complete the work, but as all the work is comparative, the accuracy of these assumptions will not in any way affect the results.

In each case the Dyson method of design and analysis of propellers has been followed.

Table 2 gives the design of a propeller where it has been assumed that the forward and after screws are free to run at different speeds, that the two screws deliver the same effective horsepower in propelling the ship, that 680 effective horsepower will be required to propel the ship at a speed of 10 knots, and that half of this effective horsepower is delivered by each screw. From Table 2 it will be seen that the screw given in the second column is the most efficient and the most suitable for the proposition and this one has been

TABLE 4

If both propellers run at same speed, $S = .120$ and $R_d = 116.9$

$IHP_{d(a)} = \frac{12 \times 1,610 \times 871}{.077 \times 3,310} = 656$	$IHP_{d(f)} = \frac{12 \times 1,610 \times 1,000}{.205 \times 2,470} = 389$
$IHP_p = \frac{656}{1.225} = 531$	$IHP_p = 389$
$10^z = 3.015 = \frac{IHP}{IHP_p}$	$10^z = 4.115 = \frac{IHP}{IHP_p}$
$\frac{ehp}{EHP} = .3465$	$\frac{ehp}{EHP} = .2570$
$ehp = 390$	$ehp = 290$

ehp (total) $= 390 + 290 = 680.$
IHP_d (total) $= 656 + 389 = 1,045.$
Increase of $IHP_d = 1,045 - 1,023 = 22 = 2.15$ percent.

TABLE 5.—ELECTRIC DRIVEN FERRY BOAT

D	10	10
$\frac{ehp}{EHP}$	.4	.5
ehp	496	496
EHP	1,240	992
v	10	10
$\frac{v}{V}$	.69	.73
V	14.5	13.7
C	2.88	2.88
D^2	100	100
$\frac{PA}{DA} \times ET_p = \frac{EHP \times C}{D^2 \times V}$	2.463	2.085
SBC	.7	.7
$\frac{PA}{DA}$	.276	.248
PC	.694	.704
IHP	1,787	1,408
10^z	2.597	2.058
IHP_p	688	684
K	1.225	1.225
IHP_d	843	838
V_1	17.69	15.852
$P = \frac{D \times V}{V^1}$	8.2	8.65
S	.079	.077
V^y	2,400	2,000
v^y	871	871
s	.1022	.1052
$1 - s$	.898	.8948
R_d	137.5	131

$IHP_d = 838.$
Saving in $IHP_d = 1,024 - 838 = 186 = 18.1$ percent, or
$1,045 - 838 = 207 = 19.8$ percent.

TABLE 6

	Single Screw	Twin Screws	
LWL	324	324	
B	47	47	
H	21	21	
$\frac{B}{LWL}$	.145	.145	
NBC	.76	.76	
KBC	.786	.685	
K	1.23	1.325	= thrust deduction
$\frac{H}{B}$	.447	.447	
SBC	.817	.725	
$\frac{2LAB}{H}$	10.3	10.3	
S	.21	.255	
D	16	12	= diameter
P	14.75	10.5	= pitch
$\frac{PA}{DA}$	.25	.35	= projected area divided by disk area
TS	6,000	7,650	
IT_D	2.75	4.85	
V	13.71	15.68	
v	10	10	= speed
$\frac{v}{V}$	.729	.638	
IHP	4,240	5,100	
PC	.703	.653	
EHP	2,980	3,330	
ehp	910	480	= effective horsepower
$\frac{ehp}{EHP}$	.305	.144	
10^{s}	3.444	7.524	
IHP_a	1,517	898	= indicated horsepower
Z	— .5365	— .880	
Z_s	+ .302	+ .480	
$Z + Z_s$	— .2345	— .400	
s	.1506	.1345	
$1 - s$	.8494	.8655	
R_a	81	111.5	= revolutions per minute

$2 \times 480 = 960.$

$960 - 910 = 50.$

$\frac{960}{910} = 1.055$, or 5.5 percent increase.

$1.325 - 1.23 = .095.$

$\frac{1.325}{1.23} = 1.077$, or 7.7 percent increase.

$5.5 + 7.7 = 13.2$ percent increase to use of twin screws.

$2 \times 898 = 1{,}796.$

$\frac{1{,}517}{.87} = 1{,}745.$

$1{,}796 - 1{,}745 = 51.$

TABLE 6 (*Continued*)

$\frac{51}{1{,}745} = .029 = 2.9$ percent.

selected. The design is for the after end of the ship. An analysis of this propeller for both ends of the ship is given in Table 3.

A further analysis of this screw, assuming the same speed at both ends of the ship, is given in Table 4. From Table 4 it will be seen that this method (1) requires an increase of 22 horsepower, or 2.15 percent more than (2). This indicates that very little gain is to be expected by the use of method (2) instead of method (1). In other words, the method of propulsion now in use gives practically as good results as would be obtained by running two screws at slightly different speeds so as to have them deliver equal effective horsepowers and somewhat more nearly equal indicated horsepowers. There would, however, be a slight increase in motor efficiency due to the more nearly equal loading of the two motors, so that the total increase in efficiency of propulsion would be sufficient to warrant the use of method (2) instead of method (1).

Comparison of Method (4) with (1) and (2)

It will now be shown that method (4) is more efficient than any of the other propositions. Table 5 shows the design of a screw where all the power is to be developed by the after screw, and, since there is no race from the forward screw, the effective horsepower required to be delivered will be 680 divided by 1.37, or 496.

The screw given in the second column of Table 5 will be selected, as it is the more efficient. It will be noted that $\frac{PA}{DA}$ is .248, or the same as was selected for the screw where two screws were to drive the ship. Since the screw at the forward end of the ship is not delivering any power, it will not be necessary to make a further analysis of this screw other than that contained in Table 5. From Table 5 it will be seen that the indicated horsepower required to drive the ship is only 838. This represents a saving of 18.1 percent over method (2), or a saving of 19.9 percent over method (1). From this saving there will have to be subtracted the horsepower required to turn the forward screw at a speed just sufficient to keep it from acting as a drag on the ship. While it is not known exactly what this indicated horsepower will be, experiments in a model tank have indicated that it will be very small, not more than about 4.5 percent, which will leave a gain of 13.6 percent in the first case and 15.4 percent in the second case. From this comparison it will be seen that the gain in efficiency due to the use of electricity for propulsion more than makes up for the electric conversion losses, for which 13 percent may be taken as a maximum.

Low Powered Cargo Vessels

In the case of cargo vessels of about 10 knots, requiring about 1,500 shaft horsepower, the use of Diesel electric propulsion instead of direct connected Diesel propulsion also shows up remarkably well. In the following comparison it will be assumed that twin screws will be required for a direct connected installation and that a single screw can be used for the Diesel electric drive.

Two screws have been designed for these conditions, it being assumed that with Diesel engines, direct connected, a speed of at least 110 revolutions per minute will be required. The effective horsepower required in the case of the single screw will be 910.

In Table 6 is given an analysis of the two screws by the Dyson method. Owing to increased appendage resistance (struts), as shown by Sheet No. 18 of Dyson's book, the effective horsepower required for twin screws will be 960 instead of 910, or an increase of 5½ percent. With twin screws the thrust deduction is 1.325; with a single screw it will be only 1.23, or a difference of 9½ percent. The actual increase of indicated horsepower due to increased thrust deduction will be 1.325 divided by 1.23, which equals 1.077, or an increase of 7.7 percent. The total increase due to the use of twin screws therefore will be 5½ percent plus 7.7 percent, which equals 13.2 percent, or just a little more than the electrical losses. However, it is shown in Table 6 that the total indicated horsepower required for the direct connected engine is 1,796, while that required for the Diesel electric installation is only 1,745, or a difference of 2.9 percent in favor of the Diesel electric drive. This difference is due to the fact that a more efficient screw can be designed for the low revolutions that can be used with a motor than for the high revolutions that are required for the direct connected Diesel engines.

Economy of Diesel Electric Installation

This brings out the rather remarkable fact that for low powered cargo vessels the Diesel electric installation is actually somewhat more economical than the direct connected Diesel. When in addition the question of flexibility and reliability are considered, the advantages of the Diesel electric installation are so great that shipbuilders cannot afford to ignore it.

In the foregoing comparison three-bladed screws were used for the cargo vessel, but the comparison would hold equally well for four-bladed screws. It is probably well to emphasize the fact that the main difference between the two propulsive efficiencies is due to the inherent difference between single screw and twin screw installations, and not between the actual propellers themselves.

Symbols

The symbols used in the above tables, which are the same as those set forth in Dyson's book on Screw Propellers, are defined as follows:

$L.W.L.$ = length on load waterline.
B = beam.
H = draft.
$N.B.C.$ = nominal block coefficient.
$\frac{P.A.}{D.A._4}$ = projected area ratio of 4-bladed propeller.
$\frac{P.A.}{D.A.}$ = projected area ratio of 3-bladed propeller.
P = pitch of propeller in feet.
D = diameter of propeller in feet.
$S.B.C.$ = slip block coefficient of vessel.
K = thrust deduction factor.
V = basic speed corresponding to $E.H.P.$
v = actual speed of vessel corresponding to $e.h.p.$
R_d = revolutions for $E.H.P.$
s = apparent slip of propeller at speed v.
$I.H.P.$ = indicated horsepower corresponding to $E.H.P.$ (basic).
$P.C.$ = propulsive coefficient corresponding to actual projected area ratio.
$E.H.P.$ = effective horsepower which can be delivered by the propeller under basic conditions.
S = apparent slip of propeller at basic speed V under basic conditions of power and resistance.
y = values of exponents in V^y and v^y in equation for making an estimate of revolutions due to a change in conditions resulting from change in power accompanied by corresponding change in speed.
$I.H.P._p$ = indicated horsepower of propelling engine without thrust deduction.
$I.H.P._d$ = indicated horsepower of propelling engine with thrust deduction.
$e.h.p.$ = net effective horsepower required to tow the hull at any given speed, the hull being fitted with all appendages.
C = constant.
ET_p = effective thrust of propeller per square inch of projected area.
$V_1 = \frac{T.S. \times (1-s)}{\pi \times 101.33}$ (used only to simplify calculations).
KBC = thrust deduction block coefficient.
$2LAB$ = twice the length of the after body.
TS = tip speed of propeller in feet per minute under basic conditions.
IT_D = indicated thrust per square inch of disk area of the propeller under basic conditions.
Z = value of exponent in the equation for power at other than basic condition.
Z_s = value of exponent in equation for slip at other than basic condition.

Leaky Boiler Joints

The danger arising from non-attendance to a leaky boiler joint was recently demonstrated on a dredger, with results that might well have proved fatal. The joint at a manhole door blew out, with the result that the contents of the boiler were emptied into the engine room, severely scalding the engineer, but, happily, without fatal results. It was proved at the subsequent Board of Trade inquiry that as a result of corrosion around the flange of the boiler plate, and also on the spigot of the door itself, the door was a very slack fit in the manhole, and, owing to the absence of attention and tightening up while pressure was being raised, the joint was forced between the spigot and the flange. The actual amount of slackness due to corrosion amounted to no less than 25/32 inch, instead of about ⅛ inch in any one direction, which was the amount when the new doors were fitted. The leakage of steam or water at any point is always the cause of rapid corrosion, and apart from the danger of weakening the plates, if the corrosion is such that it takes away the support at the side of the joint, it is liable to lead to blowing out of the latter. It may be mentioned that, in good practice, manhole doors are recessed to take the flange, with the result that the joint has support on both sides, thus reducing considerably the possibility of it being blown out.

Pipe Bending Hints*

BY W. F. SCHAPHORST, M. E.

After fifteen years of experience with work involving pipe bending, it occurs to me that the following precautionary remarks may be of value or interest:

In bending large pipe, fill with dry sand and plug the ends. Heat to a red heat in localities to be bent and bend. Be sure that the sand is dry. Where bends are slight it is often unnecessary to use sand or rosin. The object of sand or rosin is simply to keep the side of the pipe from collapsing or to prevent reduction of flow area. If wet sand is used and if the ends are plugged, the pipe may burst when heated, due to the steam pressure generated.

Rosin, also, is good. But there is a "right way" and possibly several wrong ways to use it. An example of a wrong way was recently brought to my attention where a "mechanic" filled the pipe with rosin, plugged the ends and heated the pipe at the place where he wanted to bend it. He watched for a "red heat" just as he would had he filled the pipe with sand. The result was a violent explosion.

The way to use rosin is to pour it into the pipe and allow it to cool and harden. As soon as the rosin is hard, bend the pipe cold. Don't heat it. Then, after the pipe is bent, heat the pipe all over sufficiently to melt and remove the rosin.

There are many excellent mechanical devices on the market for bending pipe. To bend large, stiff pipe slightly and inexpensively there is nothing handier or more efficient, in my judgment, than a hydraulic pipe bender driven by a hand pump.

Shipping Under the New Administration

"Under New Management" Sign May Be Put Up Over the Office of the Government-Owned Merchant Marine

BY WALDON FAWCETT

ONE effect of the decisive Republican victory in the national election in November is to push to the fore, with greater emphasis than it would otherwise enjoy, the question whether there shall be a complete reorganization of the administration of the nation's governmentally-owned merchant marine. With a Republican President in the White House and with the party in power fortified by a "working majority" in each house of Congress, it is obvious that there is unquestioned opportunity to put over a new plan for the operation of Uncle Sam's merchant tonnage if such revolutionary action finds approval as a principle of party policy.

There is no justification, it should be pointed out just here, for a suspicion that the projected shake-up of merchant marine administrative machinery is due simply to the accession to power of the political party opposite to that which instituted the United States Shipping Board. As a matter of fact there has been, ever since the close of the war, an element of the membership of Congress that has been dissatisfied with the existing executive organization that has administered the Federal merchant fleet. This dissatisfaction has been directed not so much against individuals as against the system.

Unrest May Lead to Reorganization

Manifestation of the unrest was found in the proposal in Congress in the early summer of 1919 that the Shipping Board be abolished and there be substituted a new Federal department with a Cabinet officer at its head. It is no secret, either, that Senator Jones, author of the recently enacted Merchant Marine Act, would have preferred that the entire responsibility for the construction, operation and upkeep of government-owned vessels be taken out of the hands of the Shipping Board and vested in a separate operating corporation. In short, he would have been better satisfied had the new law provided for a shipping corporation that would have borne to the Shipping Board somewhat the same relation that the United States Railroad Administration bore, during its existence, to the Interstate Commerce Commission. He was induced to relinquish this ideal only when fellow Senators pointed out the expense to the Government of a separate organization of the kind proposed.

On the part of some persons there may be surprise that there should be such store set by the form of the nation's "shipping annex" when it is the popular understanding that Uncle Sam is to retire as speedily as possible from the ownership and operation of merchant tonnage. In answer to that it may be said that most well-informed men in the shipping and shipbuilding field realize that, whatever the intent, it will not be possible for the Government to retire from its merchant marine enterprise as abruptly as a section of the lay public expects. Indeed, it is clearly within the realms of possibility that Uncle Sam will continue shipping operations indefinitely, albeit on a gradually diminishing scale. This continuance is, indeed, implied by the obligation that has been assumed to maintain "adequate" service between the continental United States and the nation's various insular possessions.

The Case of Marine Insurance

In further proof of the certainty of continued governmental participation in merchant marine activities and kindred responsibilities it may be permissible to digress just here to cite the illustrative example of marine insurance. As realization grows that American private capital will not be able to make headway in the provision of marine insurance unless there be wider latitude for combination and that such leniency waits upon legislation in a number of different states of the Union there is a growing conviction on the part of many members of Congress that there is nothing for it but for the National Government to take the role of marine underwriter. Yet another factor that insures prolonged contact between the Government and private shipping and shipbuilding interests is that involved in the "adjustments" to be made on war contracts. The delay in the settlement of the claims of the wooden shipbuilders indicates how tedious is this process and accounts for the interest that must be felt in the Federal machinery for marine administration even by the men within the industry who expect to have no further participation in the governmental programme after the current incidents are closed.

Harding's Attitude

President-elect Harding is known to have definite and well-considered convictions on the subject of the American merchant marine, and future history in this quarter will, manifestly, be influenced by his application of these principles to the problem of administrative policy. The temper of Congress on the issue will be determined in no small degree, it is expected, by the tenor of the final report to be submitted by a special committee of the House of Representatives, which has been engaged, for some months past, in an investigation of the Shipping Board. This committee, of which Representative Walsh of Massachusetts is chairman, continued its investigation during the recess of the National Legislature. A report will be ready for submission early in the final session of the 66th Congress, but it remains to be determined whether this report will stand as the committee's complete verdict or whether it will have the status of a preliminary report to be followed later by conclusions adduced in the light of the latter-day activities of the Shipping Board.

On the part of at least a portion of the members of the special Congressional committee the revelations incident to the above-mentioned investigation of the Shipping Board have but deepened the conviction already held that the management of the government-owned merchant marine should not be left solely to the discretion of an independent and more or less isolated branch of the Government, but should be vested in an organization closely interlocked with the several executive departments and with a spokesman in the Presidential Cabinet who would be in a position at all times to voice the needs and aspirations of the maritime establishment and enlist whatever measure of co-operation might be necessary. In short, the logic of members of this school of thought is that whereas the Shipping Board may have been well enough as a war-time expedient it is not the ideal cog to fit permanently into the established governmental machine.

Specialization in the Shipping Board

Even among Republican Senators who are more or less friendly to the principle of the Shipping Board as now existent and who are little inclined to uproot the structure, if satisfactorily capable appointments are made, there is a growing sentiment to the effect that, for the best interests of the merchant marine, there must be a distribution or segregation of responsibilities that will permit specialization within the organization. What is in mind is a plan of organization whereby one member of the Board would be at the head of a division of operations, that would have jurisdiction over charters and all the technicalities of shipping service; a second member of the Board would be in charge of "construction," and so on through the list of activities into which the complex responsibilities of the Shipping Board might naturally be subdivided.

It is recognized that such a programme of apportionment of responsibility is seemingly contrary to the spirit of the present specification which contemplates a Shipping Board sitting in council as a board of directors with representatives for the several geographical districts that have maritime interests. Champions of the new proposal insist, however, that it is more important that there be maximum specialization in accordance with technical grand divisions than that a geographical balance of power be reflected in the personnel of the Board. Moreover, they insist that specialization in the delegation of executive authority might be undertaken without disturbing the arrangement which calls for the appointment of two members of the Board from the Atlantic coast, two from the Pacific coast, one from the Gulf coast, one from the territory contiguous to the Great Lakes, and one from the interior.

The germ of the idea that bids fair to take conspicuous form in the near future was implanted during the meetings of the Committee on Commerce of the United States Senate, which resulted ultimately in the drafting of what was to go on the Federal statute books as the Merchant Marine Act. For example, during the conferences of the committee with prominent shipping men, Mr. Fields S. Pendleton, of New York, shipbuilder, shipowner and ship operator, pleaded eloquently for the retention of all the large vessels (passenger as well as cargo carriers) acquired by the Government during the war and for their operation under Government control or Government supervision.

Government Corporation Suggested

While he did not elaborate his suggestion, Mr. Pendleton left with the Commerce Committee the basic proposal that the ships be turned over to a corporation which, for all that it would be separate and distinct from the Shipping Board,—a Government subsidiary, in a sense,—would nevertheless partake of many of the characteristics of a private corporation. In the original outline it was suggested that there be Government representatives, such as a representative of the Department of Commerce, on the board of directors, but that the ship operating corporation be left free to work out its own salvation in its own way so long as it was enabled to make satisfactory reports to the Government.

Chairman Jones, who fathered the Merchant Marine Act that bears his name, expressed from the outset considerable sympathy with this idea. On one occasion when Mr. Pendleton had suggested that the Panama Steamship Company might perhaps serve as a model for an operating corporation to carry on the Government's shipping enterprises, Senator Jones commented: "I think that there is a good deal of force in the suggestion. I think that a Government corporation organized so as to run like a private corporation is the thing. We never hear anything about the Panama Steamship Company and its operations. Nobody suggests it is influenced politically. Yet it is going right on, doing business, suing and being sued; in short, doing business like a private corporation."

The Opposition

There is a certain element in Congress and outside that is antagonistic to any plan for setting up an operating administration to take over the Government-owned tonnage for fear that the mere fact that there is an operating company ready to hand will tend to persuade the retention of Government tonnage instead of its speedy disposition by outright sale to private parties. This portion of the body politic would fain see Uncle Sam relinquish, with the least possible delay, all responsibilities as a shipowner and ship operator and is apprehensive of any new influence that might tend to give permanence to the war-time arrangements. Arrayed against this contingent is one of equally resolute purpose that favors retention and operation of the ships by the Government. In justification of this latter attitude it is represented that "the great fear" of other maritime nations is that the United States Shipping Board will continue to hold its fleet. By way of evidence to prove that the United States should do precisely what her greatest rivals desire that she shall not do there has been extensively quoted in the discussions at Washington the statement of Lord Inchcape, president of the Peninsular & Oriental Steamship Company, in the seventy-ninth annual report of that corporation, in which he expressed the hope that the Government of the United States "will leave the shipping industry to look after itself."

While not even the most radical advocates of a reorganization of Uncle Sam's maritime administration admit that it would necessarily involve a reopening of the question of the partial "nationalization" of our merchant marine, there is recent and graphic illustration of the fact that, on the eve of a change of national executive administration, no predetermined policy can be regarded as a closed incident. The example to the contrary is found in the prospective opening of the question of Panama Canal tolls—something that has potent if indirect bearing upon the status of the American merchant marine. The pledge in the Republican platform, the comment in Senator Harding's speech of acceptance and the journey to Panama of the President-elect for the purpose of studying the problem at first hand, all bespeak the likelihood of a reversal of policy on Panama Canal tolls. And, by the by, far-sighted students of international relations foresee, as the possible sequel to such reversal, a new competitive tension between maritime Britain and maritime America that may bring in its train as a necessity that very permanent Governmental participation in the shipping industry which has appeared to many so remote a contingency.

President-Elect's Trip to Panama

The intimation from authoritative source that the trip of the President-elect to Panama is but the first step in a thorough study, in the most intimate possible manner, of the whole problem of the uplift of the American merchant marine may impel that section of Congress which always awaits to the initiative of the White House to postpone until after March 4 any effort for a shake-up in Uncle Sam's shipping offices. There remains to be reckoned with, however, a section of Congressional opinion that holds that reorganization should not be delayed a day longer than necessary. The hand of this player in the legislative game has been strengthened by the spectacle of one or two men functioning, in effect, as the Shipping Board, and will be further strengthened, perhaps, by some of the disclosures in the forthcoming report of the investigation of the Shipping Board.

In the interest of an accurate statement of the situation, it cannot be made too clear that there are members of Congress, not inconsiderable in number, who favor substitution of a Federal executive department for the Shipping Board, but who will not for a moment concede that such a shift of responsibility should carry with it any abridgment of the policy which would take Uncle Sam out of the ranks of merchant ship owners and operators. These antis on Government ownership are ready to echo the sentiment of Admiral W. S. Benson, chairman of the Shipping Board, when he said at a recent dinner: "Gladly I would, and do, pledge myself to help see that not only my own but other governments be brought to a point where they fully agree to retire absolutely from ocean carriage which could only mean uneven competition with the private owner."

Centralization of Administrative Control

Some of the most earnest advocates of a new form of shipping structure at Washington are imbued principally by a desire for the centralization of administrative control of all the Governmental agencies having to do with ships, shipbuilding and commerce. To that end they would have the Federal department, if one be created, include not merely all the responsibilities and functions now within the province of the Shipping Board, but likewise the various existing establishments dealing with maritime affairs, viz., the Coast Guard, the Bureau of Fisheries, the Bureau of Lighthouses, the Bureau of Navigation, the Steamboat Inspection Service, the Inland Waterways Commission, etc. The consideration of economy through consolidation is expected to prove the practical promise that will win for this project the heaviest support in Congress, for Congress is plainly exercised just now over the waste that results from "duplication" of Government work, thanks to parallel activities in different departments. But, overshadowing in the minds of well-wishers of the merchant marine these considerations of immediate practicability is the large one that a Federal department of marine would provide a specific Governmental agency that could at all times work consistently for the fostering, promotion and development of the merchant marine.

Finally, there have appeared very recently developments, actual or prospective, in international relations that make it appear that, for the sake of diplomacy, it might be most helpful to have the United States merchant marine administration most closely co-ordinated with the other principal branches of the Government and with a voice in Cabinet councils. The impending resurrection of the question of Panama Canal tolls has already been mentioned, and it may have more ramifications than most marine men may suspect, extending mayhap to the question of tolls at the Suez and other canals and even to the remotely related question of naval armaments. The abrogation or amendment of existing commercial treaties, as prescribed in the new Merchant Marine Act, presupposes extended international negotiation and friction over merchant marine policies has lately been injected into the relations between the United States and Japan. The United States laws relative to coastwise traffic also continue to irritate some other nations, as witness the recent remarks of Sir Auckland Geddes, British ambassador, as to the "far-reaching derangements" that might result should the British Empire say tit for tat. And, finally, the impending general revision of the United States tariff laws, which is slated for the first session of the 67th Congress, is almost certain to beget reactions in international trade that will affect the American merchant marine and consequently make it desirable that there be complete harmony between the United States merchant marine policy and the general Government policies.

The Morning After

The Shipping "Jag" Is Over—A Period of Reform and New Resolves Must Be Faced

by "old scotch"

I WONDER how many men there are in the shipping game who have awakened at some time in the morning and wondered just where he had been the night before and what he had done! Those of you who have been that way, please stand up and be counted! Now don't crowd the main aisles! Stand up where you are. That will do, thank you. I see the ayes have it, so there is no need of counting. Anyhow, it won't happen again very soon, I'll bet, unless you all go abroad or have a stand-in with the bootleggers.

I merely wanted to ascertain if you could understand the title of this brief sketch I'm going to give. I have read a great deal about the symptons in books, but was afraid you might not have been so fortunate. According to pages 1 to 5 of chapter I of the book I read the dope in, the victim is supposed to sit up in bed, pry his eyes open one at a time, look around to see if his clothes are all there, reach out for his vest and find if his watch is there and going, then count the money in his various pockets, if there be any remaining. As consciousness gradually asserts itself, dim recollections of feeling rich the night before, everything looking roseate, fine companionship and funny incidents flash across his fevered brain. Then follow sharp pains in the head and a burning desire for ice water. Normally the next thing to do is to crawl out of bed, pull on your disordered raiment, and utter great vows of "never again." You are in a humble and apologetic mood with all the world, and firmly resolve that thereafter you will stick in the straight and narrow path, work hard, save your money, buy your wife a new hat, get Willie a set of tools he has yearned for, and in general show the world that you henceforth will lead an upstanding and exemplary life. Away with all foolishness, now for straight out business!

Those feelings and sentiments, dear readers, are exactly what the people in the shipping business are now going through or are about to encounter. We have been on a gigantic jag for the past three or four years, and the cold, gray dawn of the morning after is peeking through the blinds. Whether you are a shipbuilder or a riveter, a chief engineer or a coal passer, you must realize that you have got to go through a period of reform and new resolves. Shipowners are no longer going to importune you to build their vessels at almost any price you name, nor are foremen or chief engineers going to beg you to work for them at fancy wages, which will be increased every time you think you need a new silk shirt or a new set of tires for your Ford limousine. We are all going to get down to brass tacks and cut out all foolishness. Men in the shipyards will have to deliver eight hours' good solid work every day and cut out all loafing and crap shooting, or they will find that the boss has a half dozen men waiting for the jobs the malingerers don't appreciate. Men on the ships will have to deliver a proper return for their pay, and do most of their own repairs as they formerly were glad to do, or there won't be any ship to sail on; then back to the boarding houses where you can only stay so long as your coin holds out.

Like the man recovering from the "night before," we are all in a condition to make many new resolutions and start in to put them in effect. In the shipping business there is now and will probably be for some months to come plenty of work for those who will work efficiently, but the day of the slacker and the malingerer has passed into one of those dreams of the good time we all had the night before. If you don't believe it, just continue the way some of you are still going and see how long it will be before someone slips you a blue ticket and an order on the paymaster for all time to date.

Don't worry about the high cost of living—that is on the slide, too; just look at what has happened and is happening to the various profiteers. The "jag" is over for them as well as it is for you. Some of them will get away with the rough stuff they are still forcing on the public, but their day of reckoning is rapidly approaching. It's an old saying that "what goes up must come down," and we are daily watching the descent of some of our inflated commodities. High prices and high wages are like rows of bricks: as each one goes down it pulls the one nearest to it down on the same level.

Every launching in the shipyards nowadays makes one less ship to work on. There will be other vessels to take their places, just as soon as the costs of material and labor come down to a reasonable basis, and not before. Wages need not come down so much, if you increase your output, but no one who has money is going to put it into new ships where a dollar invested now will be worth only half that much two years hence. Therefore a greater output for the money received on the part of the riveter, the boiler maker and the machinist means more attractive investment for the investor.

For those of you who go to sea there will be plenty of work providing you attend to your business and don't demand wages which no one can pay and make a little for themselves on the side. Many of the men now working in the shipyards can find plenty of employment on the operating ships if they are willing to work hard and watch out for the interests of the owners as well as they look after their own. American ships can't compete with foreigners unless every one on the ships does his best to make it pay to operate them in competition with the ships of all other nations. For the past five years (during the "jag") anything that could keep afloat, no matter how badly it was managed, could make money and everyone formed bad habits, from shipowner to forecastle boy, thinking that the "jag" would continue indefinitely. The "morning after" had hit shipping almost before any other industry, so the good resolves and resolutions must naturally be put in effect on our ships first.

It is but human nature for any of us to brace up and reform when we feel in a humble attitude. To get in a thoroughly humble condition there is nothing so efficient as being out of a job for a couple of months and "pressing the bricks" as you hunt from shop to shop or from ship to ship trying to connect with somebody's good payroll. Many of you youngsters in the shipping business have never experienced that delightful sensation and never have had the cold December winds chasing through the cracks in your last year's Kelly while you hoof it from place to place and get the frosty stare as your reward. A small amount of experience like that does some of us a lot of good, and just such a condition is coming to us, if we don't do some "next morning" reforming mighty soon. The bills for running our Shipping Board ships in a devil-may-care way won't much longer be paid and no questions asked.

There is a great reform going to be instituted in all shipyards and on board all American ships. The American people as a whole realized that the "jag" was over,

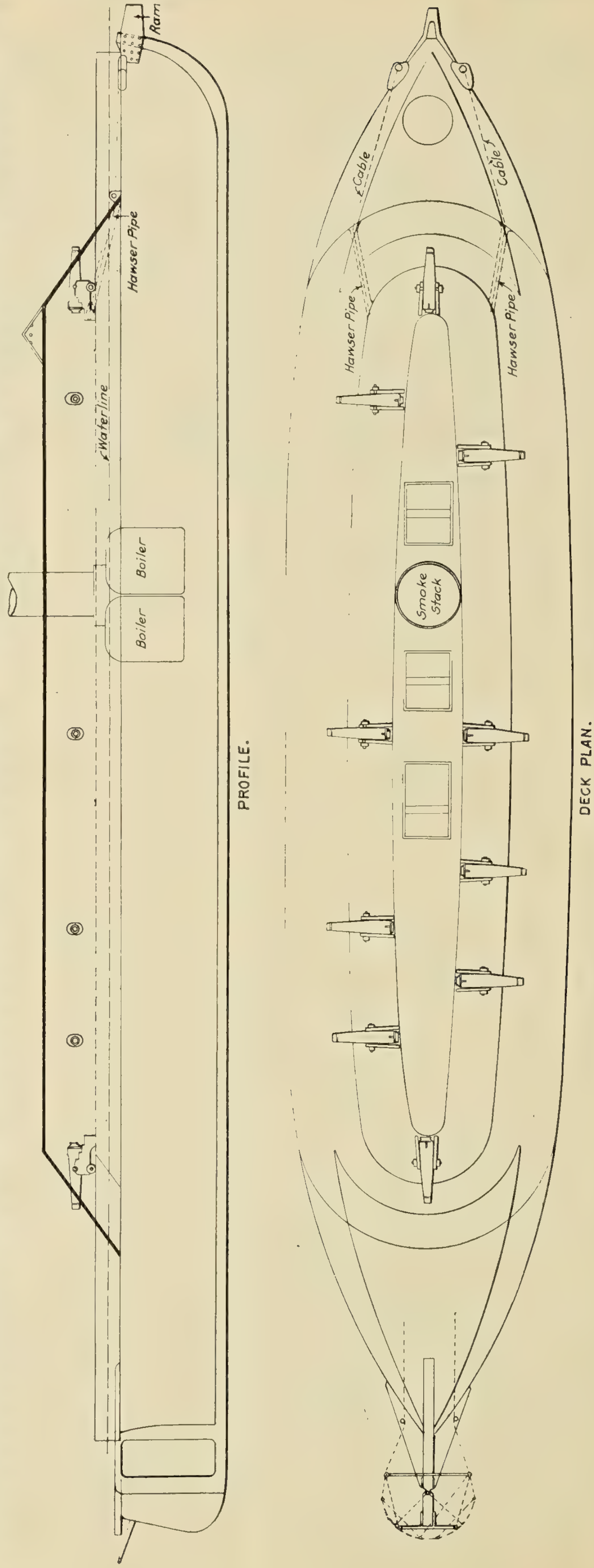


Fig. 1.—Original Plan for Conversion of Steamer *Merrimac* Into an Iron-Clad

and we have got to reform, or else that 6,000,000 popular majority last November 2nd doesn't mean anything. Naturally the easiest way to reform is to begin on the other fellow. That is just what this great political turnover meant, that the "other fellows" who have been running the Government and the Shipping Board have got to stop spending the public money so lavishly. As a matter of fact, the best way to reform in money spending is for each one of us to constitute himself a committee of one to see that we stop wasting our own money individually, and that we try to increase our individual production no matter what part of the shipping game we are engaged in pushing along.

Most "jags," collective or individual, are periods of waste and destruction—seldom is there anything you can count on as an asset when you sum up. In this great national debauch we have indulged in our dear old Uncle Sam wakes up, however, and finds a good-sized fleet of merchant ships on his hands. We, as his crew, want to get ourselves in a good humble attitude and make firm resolves that we are going to put those ships to work and form a real merchant marine, one that can and will compete with the ships of all other nations. "Jag" methods such as we have all been indulging in won't go any longer. Cut out the silk shirts and the diamond rings, get on your patched-up dungarees, and go at the jobs as if you meant it! If you don't begin right away in all American shipyards and on all American ships, that well-known firm of Street, Walker & Company will be taking on lots of new hands.

The First American Iron-Clad—the Merrimac

BY COMMANDER G. A. BISSET, C. C., U. S. N.

THE illustration on the opposite page is a reproduction of the original plans prepared by Naval Constructor John L. Porter, of the Confederate States Navy, for the conversion of the steamer *Merrimac* into an iron-clad.

The vessel was 262 feet 9 inches long from the stem to the after side of the stern post. The distance from the stem to the forward end of the shield or armor was 29 feet 6 inches. The distance from the tiller to the after part of the shield was 55 feet. The length of the shield was 178 feet 3 inches. The shield was fitted at an angle with the horizontal of 35 degrees. The total thickness of the shield was 4 inches, made up of two layers of iron 12 inches wide by 2 inches thick, one layer being horizontal and the other at right angles thereto. The wood backing was 22 inches thick made up of three layers of wood, each layer being calked. The total estimated cost of the work was $172,523. The actual cost is not available. The order to start the work was issued on July 11, 1861, and the *Merrimac* first engaged in battle on March 8 and 9, 1862.

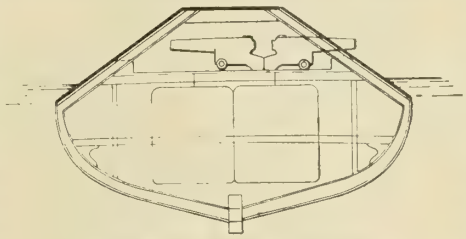


Fig. 2.—Section of *Merrimac*

The eaves of the vessel, that is, the lower edge of the armor, as well as the main deck forward and aft of the shield, were 2 feet under water. These decks were protected by one inch of iron. The original armament of the vessel was two 7-inch rifle guns, one at each end, and eight smooth bore 9-inch Dahlgren guns. The draft of the vessel was 21 feet forward and 22 feet aft.

While Mr. Porter did not consider the design of the *Merrimac* a good one, and would not have used that design for a new vessel, it was thought to be the best that could be done in the way of adaptation of the existing vessel, which had been burned to the water's edge. The decks forward and aft, as well as the eaves, being under water, caused the stability of the vessel to be very unsatisfactory, as was recognized by Mr. Porter at the time.

The historical accounts of the battle between the *Monitor* and the *Merrimac,* naturally, being dictated by the eventual victor of the war, favor the opinion that the battle was won by the *Monitor*. The truth of the matter appears to be that the *Monitor* actually withdrew from the fight on March 9 and, moreover, on later occasions refused battle when it was offered by the *Merrimac*.

The *Merrimac* was blown up on May 11, 1862, by order of Commodore Tatnall, her commanding officer, at the time of the evacuation of Norfolk by the Confederate forces. This action of Commander Tatnall, in view of our present knowledge of the effect of the *Merrimac* on the morale of the Union fleet, was a serious tactical error.

Piston Displacement, Velocity and Acceleration for Reciprocating Engines

BY JOHN L. BOGERT*

IT seems rather singular that, in the one hundred and fifty odd years that have elapsed since the combination of crank and connecting rod was suggested for converting reciprocating into rotary motion, no tables of displacement, velocity ratio and acceleration for the reciprocating member of the combination, in terms of the constant angular movement of the rotary member, appear to have been published. For the surveyor and the navigator, to say nothing of the astronomer, tables have been prepared for many years giving every function of every angle, both natural and logarithmic, besides all other data that can in any way shorten their labors. Writers on the reciprocating steam, gas and oil engine, however, have been content to point out the correct mathematical expressions for piston displacement, velocity and acceleration, and then inform the reader that these expressions are too troublesome to use and that approximations resulting from either the application of the binomial theorem or a Fourier series are much more serviceable. In view of the above, and in an endeavor to lighten the preliminary work for those engaged in the design of reciprocating machinery, the following tables and diagrams have been prepared.

There are given the two proofs, usually found in text books, for the expression of the relative velocity of the crank-driven crosshead or piston when the velocity of the crankpin is taken as unity and constant; also the two usual proofs for the ratio of the tangential pressure on the crankpin to the momentary load on the piston. The crank angle which should always be the independent variable is called "theta" and the displacement of the piston or crosshead from its inner dead

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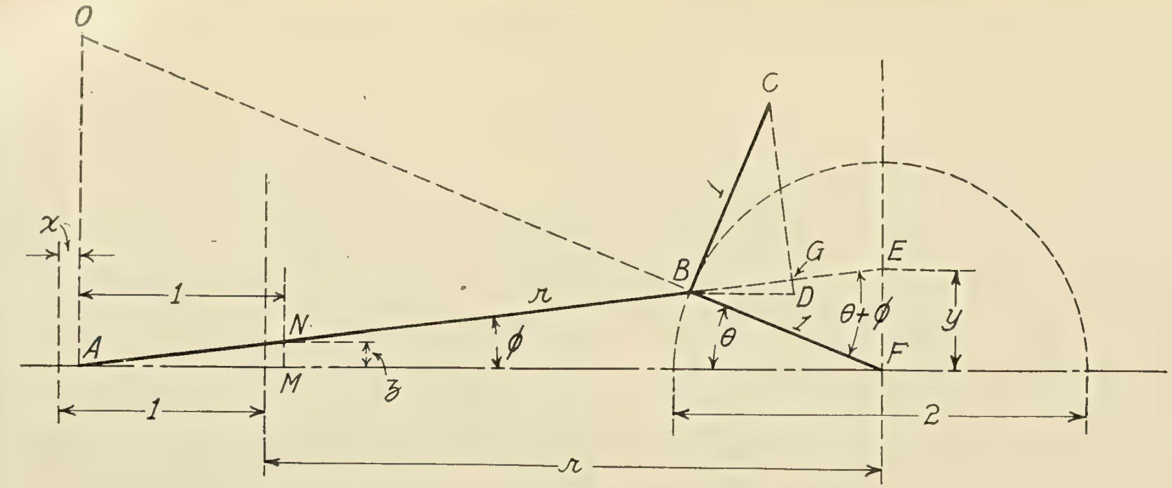


Fig. 1

Velocity of crankpin (BC) taken as unity = crank radius (BF).

Velocity of crosshead : velocity of crankpin : : $OA : OB :: EF : BF :: y : 1$.

Triangle CBD = triangle BEF.

BG = projection of BD on AE = projection of BC.

BD = crosshead velocity if BC = crankpin velocity.

Piston load (AM) taken as equal to unity.

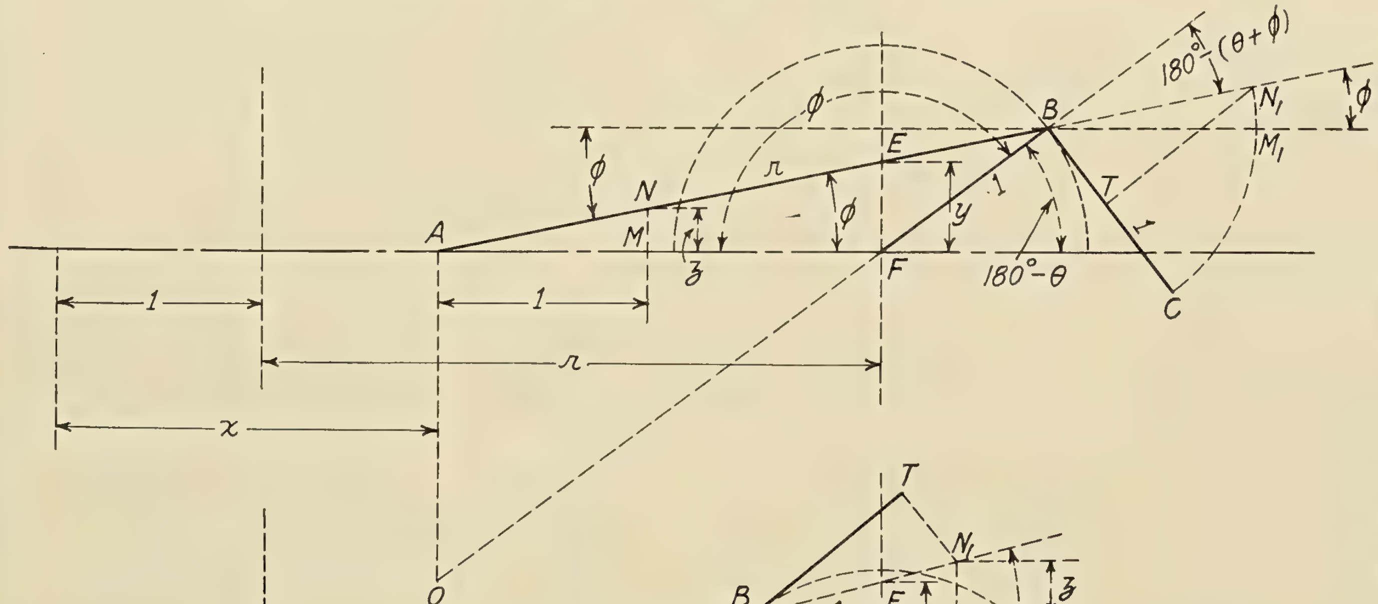


Fig. 2

$BF : EF :: \sin BEF : \sin EBF :: \cos \phi : \sin (\Theta + \phi)$.

Therefore

$$EF = BF \times \sin (\Theta + \phi) \div \cos \phi = \frac{\sin (\Theta + \phi)}{\cos \phi}.$$

Crosshead thrust : piston load : : $NM : AM :: z : 1$.

Piston velocity × piston load = crankpin velocity × crankpin load = y.

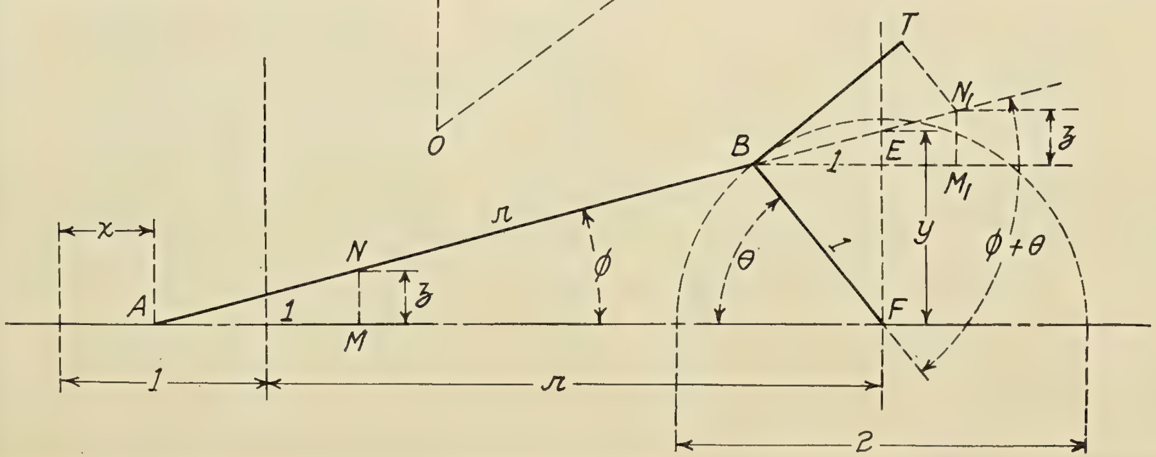


Fig. 3

Then $BM_1 = AM$ taken = piston load.

and BN_1 = connecting rod thrust,

But BT = tangential thrust on crankpin.

and $BT = BN_1 \times \sin (\Theta + \phi)$,

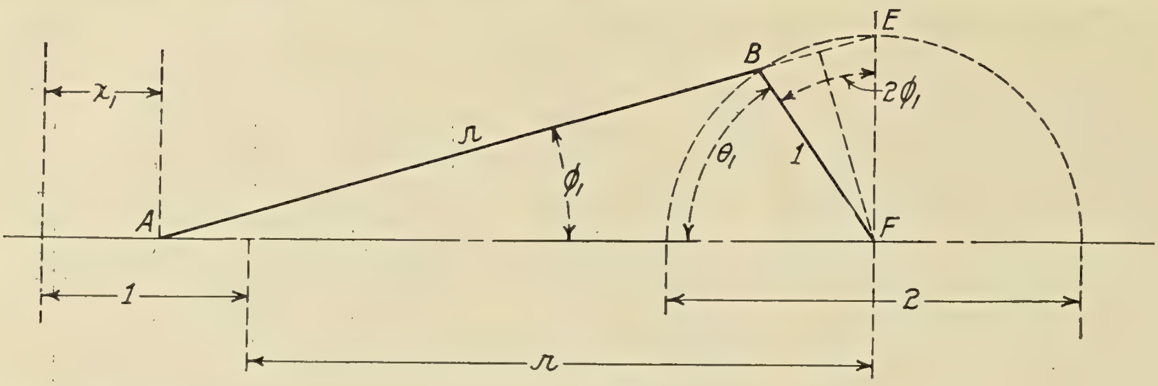
Hence $BN_1 = BM_1 \div \cos \phi$.

$$BT = \frac{\sin (\Theta + \phi)}{\cos \phi} = EF = y.$$

Table I.—Piston Displacement, Velocity and Acceleration for Various Ratios of Connecting Rod to Crank, Unity Being the Velocity of the Crankpin

Angle of Crank	$r = 4.00$			$r = 4.25$			$r = 4.50$		
	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$
0°	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
5°	.00476	.10887	.02179	.00470	.10759	.02051	.00465	.10645	.01937
10°	.01896	.21644	.04345	.01874	.21392	.04089	.01855	.21168	.03862
15°	.04246	.32145	.06484	.04196	.31775	.06101	.04152	.31447	.05761
20°	.07496	.42266	.08582	.07409	.41789	.08074	.07332	.41365	.07622
25°	.11608	.51891	.10625	.11476	.51319	.099935	.11358	.50811	.09433
30°	.16535	.60911	.12599	.16349	.60260	.11847	.16184	.59682	.11180
35°	.22218	.69226	.14489	.21973	.68515	.13620	.21755	.67885	.12851
40°	.28594	.76751	.16281	.28285	.76000	.15300	.28010	.75334	.14432
45°	.35589	.83411	.17961	.35213	.82642	.16873	.34880	.81962	.15911
50°	.43125	.89147	.19512	.42682	.88383	.18325	.42290	.87709	.17275
55°	.51120	.93916	.20922	.50611	.93182	.19642	.50161	.92534	.18513
60°	.59488	.97691	.22176	.58917	.97009	.20814	.58412	.96408	.19612
65°	.68141	1.00462	.23263	.67514	.99855	.21827	.66959	.99320	.20562
70°	.76992	1.02235	.24169	.76317	1.01723	.22672	.75719	1.01272	.21353
75°	.85956	1.03033	.24885	.85240	1.02633	.23338	.84607	1.02281	.21977
80°	.94948	1.02892	.25402	.94203	1.02617	.23820	.93543	1.02375	.22428
85°	1.03888	1.01861	.25715	1.03125	1.01721	.24112	1.02450	1.01598	.22701
90°	1.12702	1.00000	.25820	1.11932	1.00000	.24209	1.11252	1.00000	.22792
95°	1.21319	.97378	.25715	1.20556	.97518	.24112	1.19881	.97641	.22701
100°	1.29677	.94070	.25402	1.28932	.94344	.23820	1.28273	.94586	.22428
105°	1.37720	.90152	.24885	1.37004	.90552	.23338	1.36371	.90904	.21977
110°	1.45397	.85703	.24169	1.44721	.86215	.22672	1.44123	.86666	.21353
115°	1.52665	.80800	.23263	1.52038	.81406	.21827	1.51483	.81941	.20562
120°	1.59488	.75515	.22176	1.58917	.76196	.20814	1.58412	.76797	.19612
125°	1.65835	.69915	.20922	1.65327	.70649	.19642	1.64876	.71297	.18513
130°	1.71683	.64062	.19512	1.71240	.64826	.18325	1.70847	.65500	.17275
135°	1.77010	.58011	.17961	1.76634	.58780	.16873	1.76301	.59460	.15911
140°	1.81803	.51807	.16281	1.81493	.52558	.15300	1.81219	.53223	.14432
145°	1.86049	.45489	.14489	1.85803	.46200	.13620	1.85586	.46831	.12851
150°	1.89740	.39089	.12599	1.89554	.39740	.11847	1.89389	.40318	.11180
155°	1.92870	.32632	.10625	1.92737	.33205	.099935	1.92620	.33712	.09433
160°	1.95434	.26138	.08582	1.95348	.26615	.08074	1.95271	.27039	.07622
165°	1.97431	.19619	.06484	1.97381	.19989	.06101	1.97338	.20317	.05761
170°	1.98858	.13086	.04345	1.98836	.13338	.04089	1.98816	.13562	.03862
175°	1.99714	.06544	.02179	1.99709	.06672	.02051	1.99704	.06786	.01937
180°	2.00000	.00000	.00000	2.00000	.00000	.00000	2.00000	.00000	.00000

Angle of Crank	$r = 4.75$			$r = 5.00$			$r = 6.00$		
	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$x = (r+1) - (\cos\Theta + \sqrt{r^2 - \sin^2\Theta})$	$y = \sin\Theta + \frac{\sin\Theta \cdot \cos\Theta}{\sqrt{r^2 - \sin^2\Theta}}$	$z = \frac{\sin\Theta}{\sqrt{r^2 - \sin^2\Theta}}$
0°	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
5°	.00461	.10544	.01835	.00457	.10452	.01743	.00444	.10163	.01453
10°	.01837	.20967	.03658	.01821	.20787	.03475	.01771	.20216	.02895
15°	.04113	.31153	.05457	.04078	.30889	.05183	.03966	.30052	.04318
20°	.07264	.40986	.07219	.07202	.40645	.06856	.07006	.39567	.05710
25°	.11253	.50358	.08933	.11158	.49950	.08483	.10860	.48661	.07061
30°	.16036	.59167	.10585	.15904	.58704	.10050	.15484	.57242	.08362
35°	.21560	.67322	.12164	.21386	.66817	.11548	.20833	.65224	.09604
40°	.27765	.74741	.13658	.27545	.74209	.12963	.26849	.72533	.10775
45°	.34582	.81356	.15054	.34315	.80812	.14286	.33470	.79102	.11868
50°	.41939	.87108	.16341	.41624	.86570	.15504	.40632	.84879	.12873
55°	.49759	.91957	.17508	.49398	.91441	.16607	.48260	.89820	.13782
60°	.57961	.95874	.18543	.57557	.95396	.17586	.56283	.93896	.14586
65°	.66465	.98845	.19437	.66021	.98420	.18431	.64623	.97089	.15280
70°	.75186	1.00872	.20182	.74708	1.00514	.19135	.73202	.99393	.15857
75°	.84043	1.01968	.20769	.83537	1.01689	.19689	.81944	1.00814	.16312
80°	.92956	1.02161	.21193	.92430	1.01969	.20090	.90773	1.01370	.16639
85°	1.01848	1.01489	.21450	1.01309	1.01391	.20332	.99612	1.01087	.16837
90°	1.10646	1.00000	.21535	1.10102	1.00000	.20412	1.08392	1.00000	.16903
95°	1.19279	.97750	.21450	1.18740	.97847	.20332	1.17043	.98152	.16837
100°	1.27686	.94801	.21193	1.27159	.94992	.20090	1.25502	.95591	.16639
105°	1.35807	.91217	.20769	1.35301	.91497	.19689	1.33708	.92371	.16312
110°	1.43590	.87067	.20182	1.43112	.87425	.19135	1.41606	.88546	.15857
115°	1.50988	.82416	.19437	1.50544	.82841	.18431	1.49146	.84173	.15280
120°	1.57961	.77331	.18543	1.57557	.77809	.17586	1.56283	.79309	.14586
125°	1.64474	.71873	.17508	1.64113	.72390	.16607	1.62976	.74010	.13782
130°	1.70497	.66101	.16341	1.70182	.66639	.15504	1.69189	.68330	.12873
135°	1.76003	.60066	.15054	1.75736	.60609	.14286	1.74892	.62319	.11868
140°	1.80974	.53816	.13658	1.80753	.54348	.12963	1.80057	.56025	.10775
145°	1.85391	.47393	.12164	1.85216	.47898	.11548	1.84663	.49491	.09604
150°	1.89241	.40833	.10585	1.89109	.41296	.10050	1.88690	.42758	.08362
155°	1.92515	.34166	.08933	1.92420	.34574	.08483	1.92121	.35862	.07061
160°	1.95202	.27418	.07219	1.95141	.27759	.06856	1.94945	.28837	.05710
165°	1.97298	.20611	.05457	1.97263	.20875	.05183	1.97151	.21711	.04318
170°	1.98798	.13762	.03658	1.98783	.13943	.03475	1.98732	.14513	.02895
175°	1.99699	.06887	.01835	1.99695	.06979	.01743	1.99683	.07268	.01453
180°	2.00000	.00000	.00000	2.00000	.00000	.00000	2.00000	.00000	.00000



$$(2 \sin \phi_1 + r) \sin \phi_1 = 1.$$

$$\left(\sin \phi_1 + \frac{r}{2}\right) \sin \phi_1 = \frac{1}{2}.$$

$$\text{Sin}^2 \phi_1 + \frac{r}{2} \sin \phi_1 = \frac{1}{2}.$$

Therefore

$$\text{Sin}^2 \phi_1 + \frac{r}{2} \sin \phi_1 + \frac{r^2}{16} = \frac{1}{2} + \frac{r^2}{16}.$$

Therefore

$$\text{Sin } \phi_1 + \frac{r}{4} = \pm \sqrt{\frac{1}{2} + \frac{r^2}{16}}.$$

$$\text{Sin } \phi_1 = \sqrt{\frac{1}{2} + \frac{r^2}{16}} - \frac{r}{4}.$$

Also

$$\text{Sin } \phi_1 = \frac{\text{Sin } \Theta_1}{r}.$$

Therefore

$$\text{Sin } \Theta_1 = r \left[\sqrt{\frac{1}{2} + \frac{r^2}{16}} - \frac{r}{4}\right]$$

Fig. 4

TABLE II.—CRANK ANGLES AT WHICH VELOCITY OF PISTON EQUALS THAT OF CRANKPIN

r = Ratio of Connecting Rod to Crank	$\sin \Theta_1 = r \left[\sqrt{\frac{1}{2} + \frac{r^2}{16}} - \frac{r}{4}\right]$	Θ_1	$x_1 = (r+1) - (\cos \Theta_1 - \sqrt{r^2 - \sin \Theta_1})$	x_2	$y_2 =$ max.	Θ_2
$r = 4.00$.......	.89898	64°, 01′, 27″	.66441	.89053	1.03088	76°, 43′, 17″
$r = 4.25$.......	.90859	65°, 18′, 41″	.68057	.89546	1.02737	77°, 24′, 07″
$r = 4.50$.......	.91696	66°, 29′, 07″	.69542	.90006	1.02445	78°, 01′, 15″
$r = 4.75$.......	.92428	67°, 33′, 36″	.70908	.90434	1.02196	78°, 35′, 08″
$r = 5.00$.......	.93070	68°, 32′, 41″	.72161	.90827	1.01983	79°, 05′, 58″
$r = 6.00$.......	.949875	71°, 46′, 56″	.763035	.92145	1.01380	80°, 46′, 32″

point "x." With the length of the crank taken as unity, the stroke must be two and the path of the crankpin through 180 degrees will equal 3.1416. The velocity of the crosshead or piston is represented by "y," unity being the velocity of the crankpin.

Six different ratios of connecting rod length to crank length are presented, representing the ratios most common to general practice, and these ratios are designated by the letter "r."

For many years the problem of the maximum velocity of the piston, the velocity of the crankpin being taken as constant, was vouchsafed no accurate analytical solution, though graphical solutions have been published. Professor Hill's solution is perfectly satisfactory, but his work involves the use of a subsidiary angle. The maximum relative velocity of the piston to the crankpin is not of as much importance, either in quantity or position, as determining the exact position when the velocity of the piston first becomes equal to that of the crankpin.

It is easily seen that when the crank stands at right angles to the line of stroke, the velocity of the piston has decreased to become once more momentarily equal to that of the crankpin, and it is the angular distance in the first quadrant, from the position of the crank when the velocity of the piston first equals that of the crankpin to the 90-degree position, that should be taken into consideration in the design of valve operating mechanism.

It would seem as if the leading face of the admission valve cam should be steeper than the back face, and, correspondingly, the slope of the leading face of the exhaust valve cam should be more gradual than its back face. This statement must be accepted with a proper allowance for the lag of the entering fluid, owing to its inertia and impedence due to the form and size of the valve and its passages.

In the case of the acceleration and retardation curves it is considered essential to draw in the cosine curve, because the crankpin box, together with its cap, bolts, nuts and the flange by which the box is secured to the connecting rod, are accelerated and retarded strictly in accordance with this cosine curve. The acceleration and retardation of the shaft or rod proper of the connecting rod lies not quite midway between the cosine curve and the curve of piston and crosshead acceleration and retardation. The wristpin box or boxes, together with caps, bolts and attaching flanges at the crosshead end of the connecting rod, accelerate and retard at the same rate as the piston, piston rod, crosshead and all other reciprocating masses, including the cooling water, if there is any, as in the case of a Diesel engine.

It has not been considered necessary or desirable, however, to attempt to set down the ordinates of the cosine curve, sine curve or 1-cosine curve, since these are readily obtained from any table of natural angular functions.

It is hoped that designing draftsmen will find herein substantial aids to the solution of some of the many problems they are called upon to deal with.

CURVES OF PISTON DISPLACEMENT, VELOCITY AND ACCELERATION

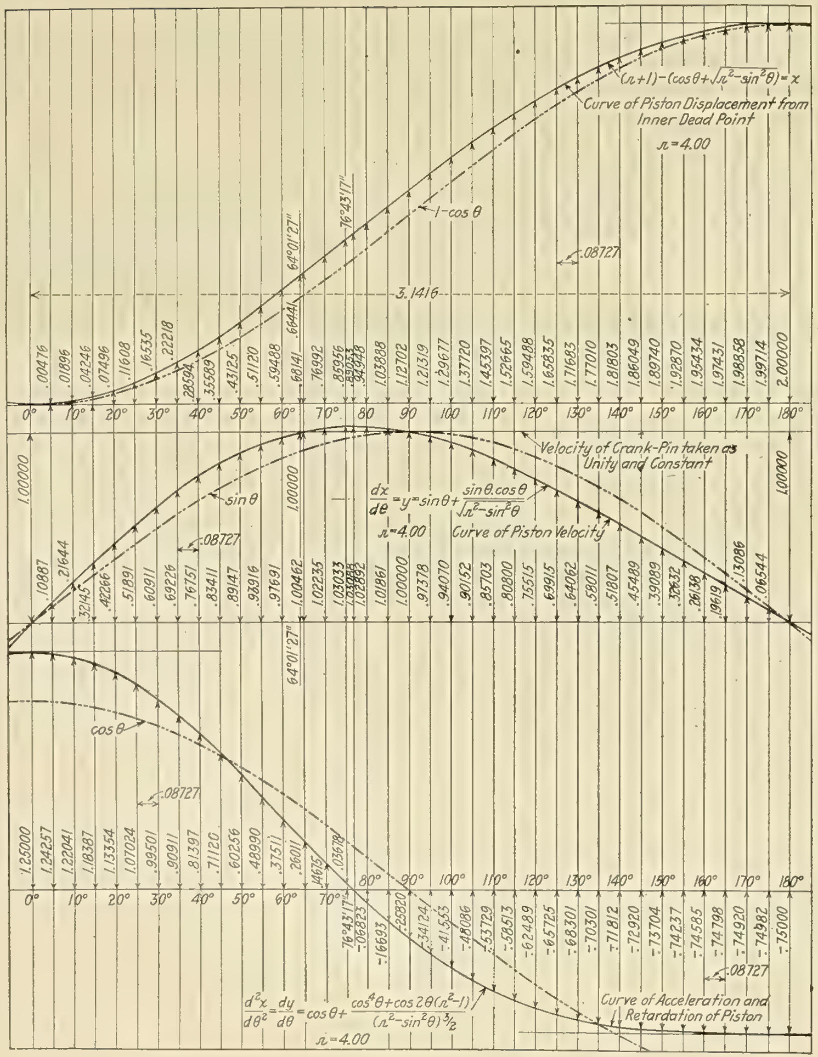


Fig. 5.—Ratio of Connecting Rod to Crank = 4.00

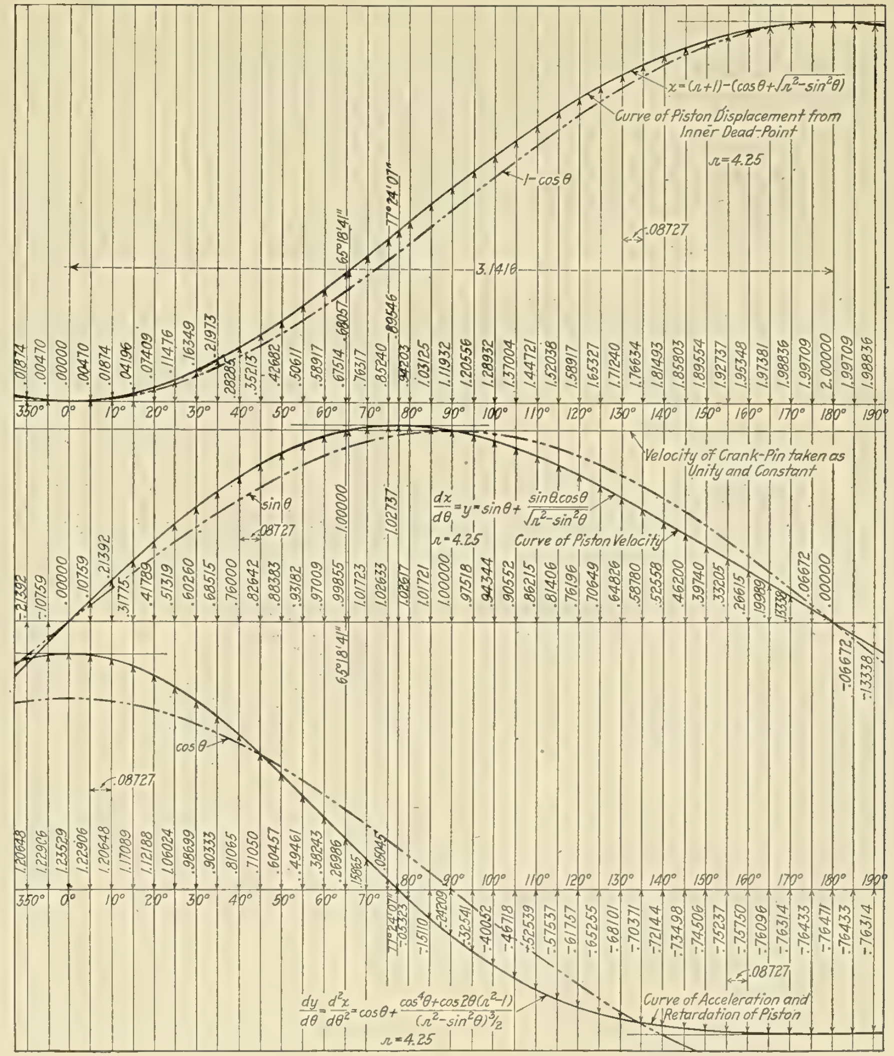


Fig. 6.—Ratio of Connecting Rod to Crank = 4.25

CURVES OF PISTON DISPLACEMENT, VELOCITY AND ACCELERATION

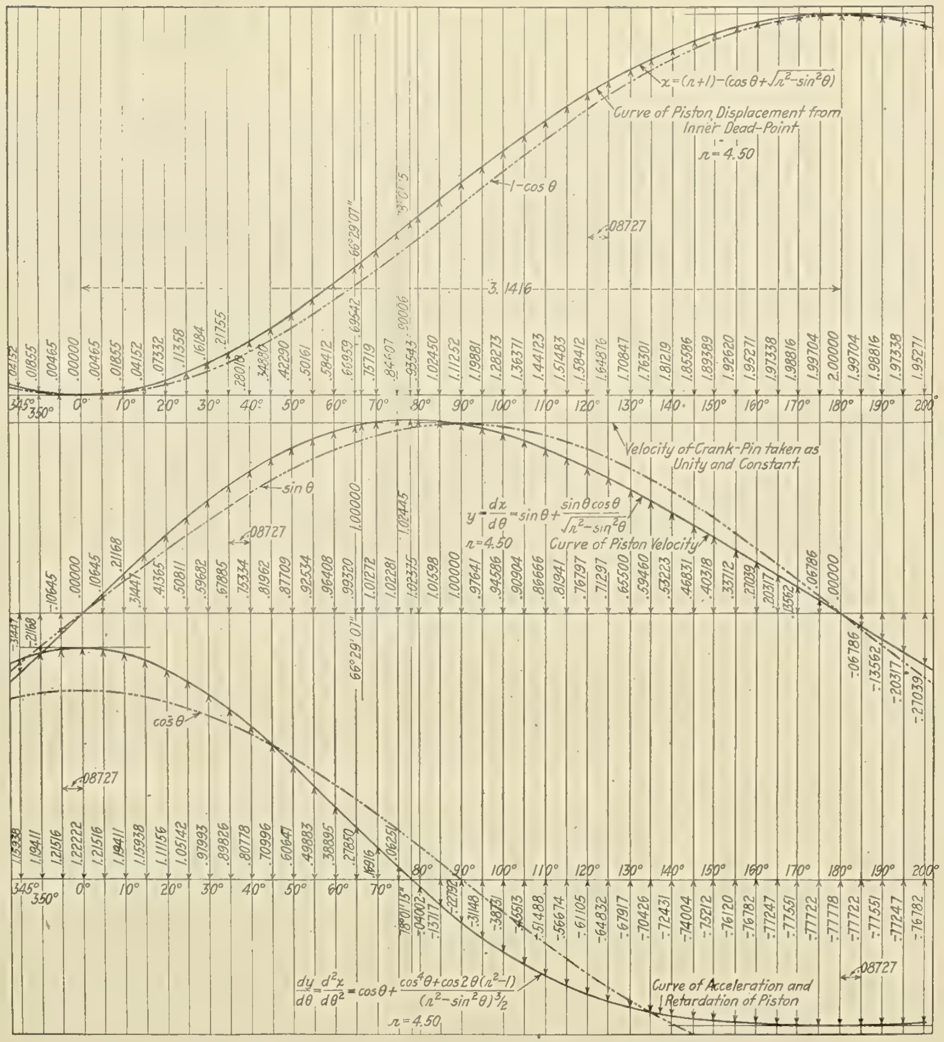


Fig. 7.—Ratio of Connecting Rod to Crank = 4.50

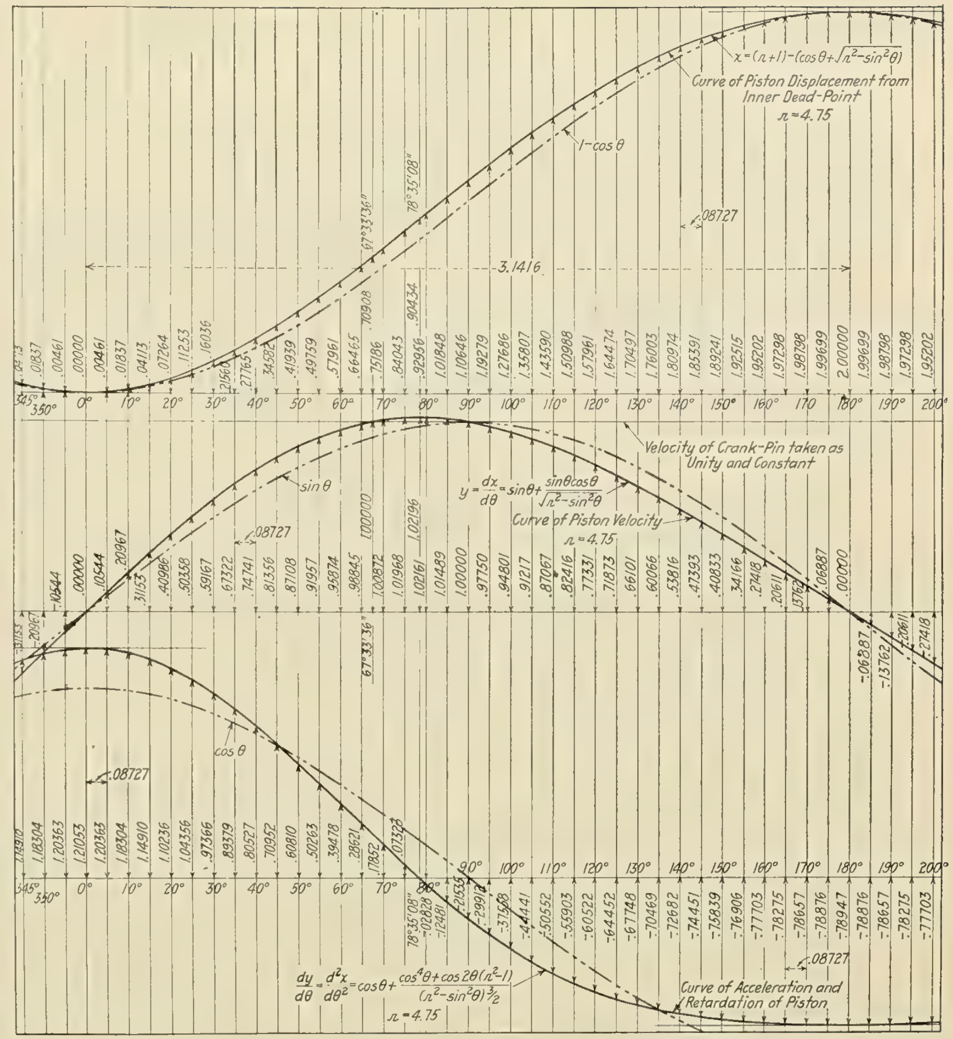


Fig. 8.—Ratio of Connecting Rod to Crank = 4.75

CURVES OF PISTON DISPLACEMENT, VELOCITY AND ACCELERATION

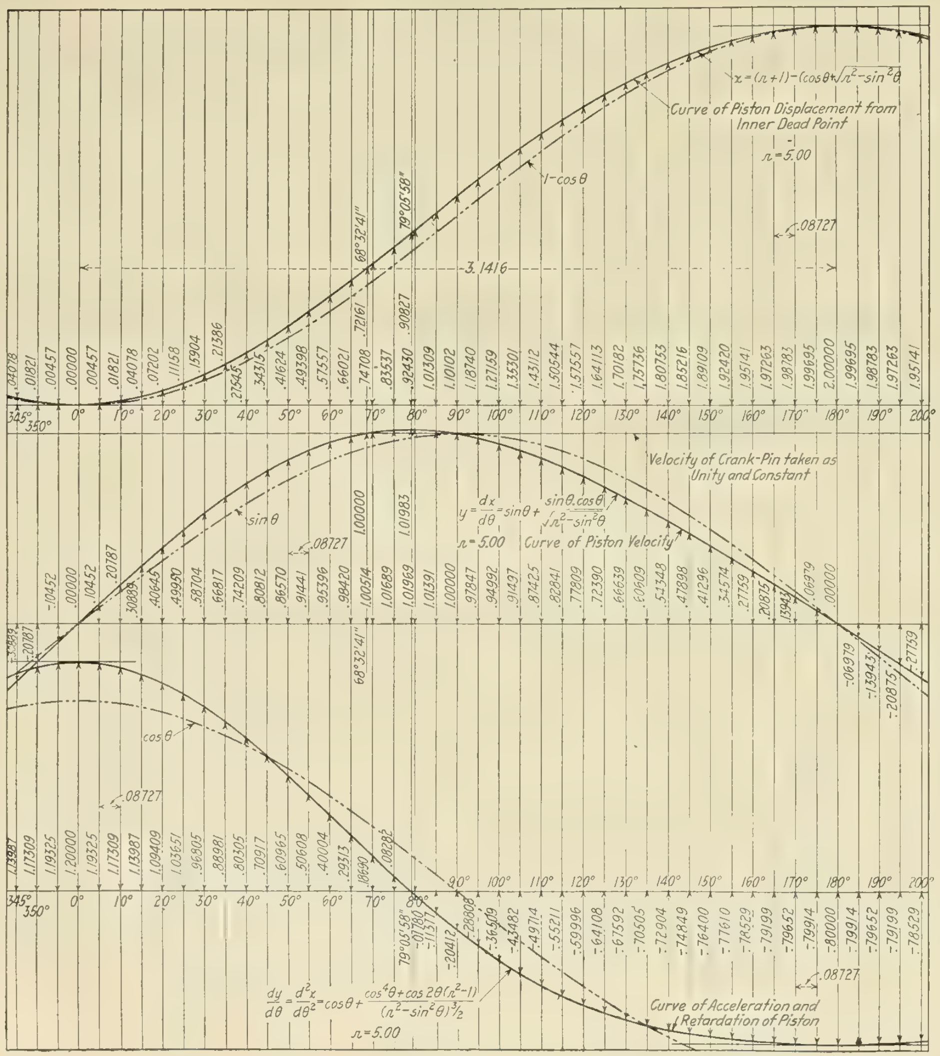


Fig. 9.—Ratio of Connecting Rod to Crank = 5.00

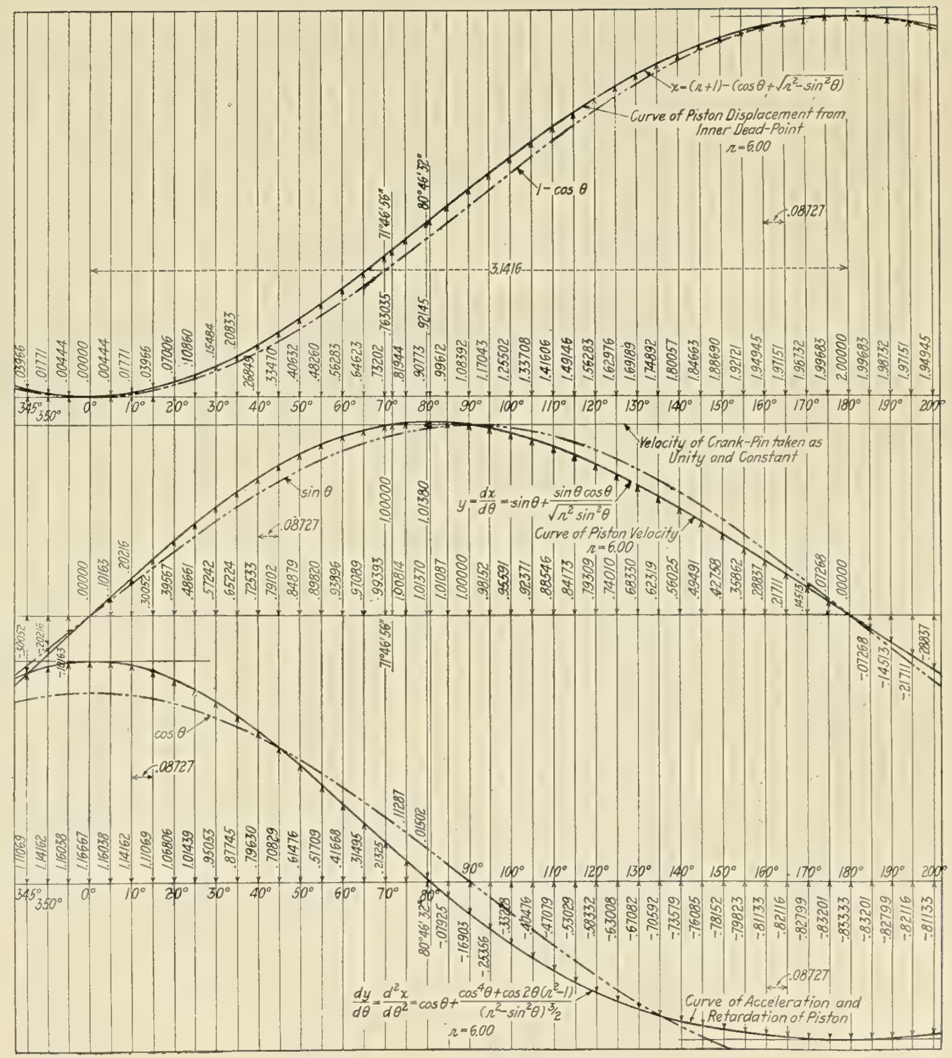


Fig. 10.—Ratio of Connecting Rod to Crank = 6.00

Economical Cargo Ships—Model Experiments*

Results of Model Experiments to Determine the Best Form for Propulsion of Full Cargo Ships

BY ALFRED J. C. ROBERTSON

THE type of lines suitable for vessels of slow and moderate speeds and of full form has received much attention of late years at the various experimental model basins, and special mention is due to the very thorough series of tests made at the Froude National Tank, London, and reported through the Institution of Naval Architects by Messrs. G. S. Baker and J. L. Kent in several recent years and to

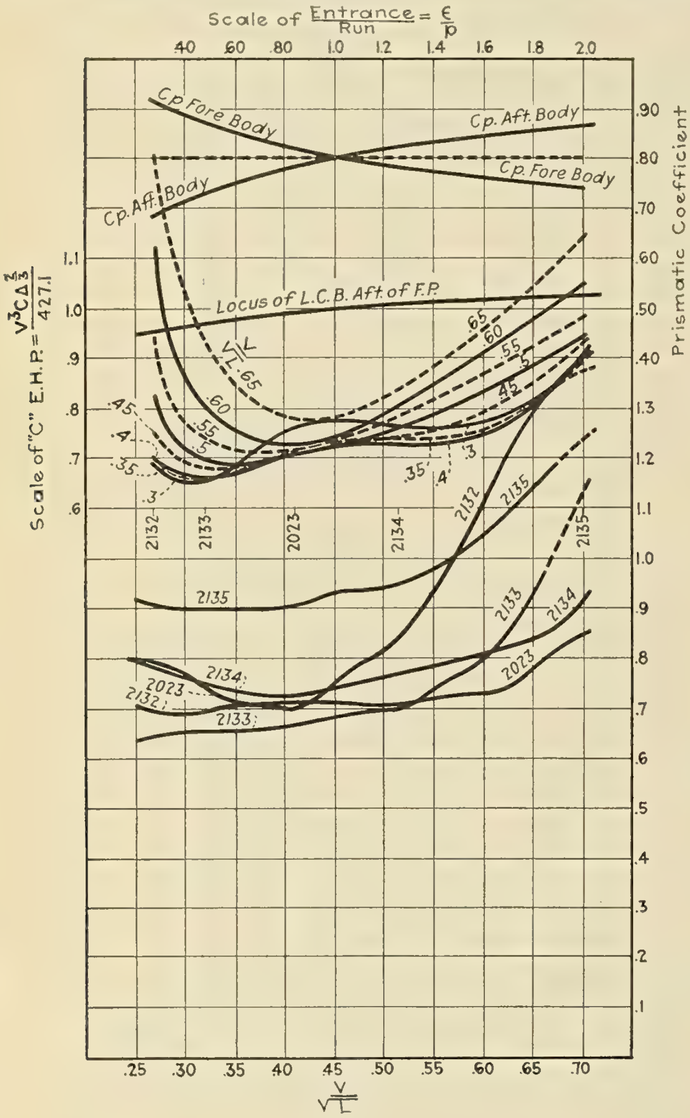


Fig. 1

Mr. McEntee's recent papers presented to the Society of Naval Architects and Marine Engineers, as well as to the earlier contributions to our knowledge of the subject made by Admiral Taylor, Dr. Sadler and other investigators.

In results of full form Admiral Taylor has shown that a certain amount of parallel middle body is necessary to produce minimum resistance, and Messrs. Baker and Kent have supplied the results of tank tests of vessels with 10 percent, 30 percent and 50 percent parallel body located amidships.

Mr. McEntee's recent papers, confirmed by Mr. Sample, have shown that the location of the parallel body forward of amidships has diminished the resistance of the model and also increased the efficiency of propulsion.

This paper covers somewhat similar ground for vessels of several prismatic coefficients exceeding .70, covering the field somewhat more fully and also supplying some further information regarding the form of areas curve associated with minimum resistance.

The experiments about to be described were conducted in two series independent of one another. The first set, designated Model 1107, consisted in the modification of the curve of areas of the afterbody (both in its area and in its curvature) of a successful cargo ship of high prismatic coefficient. The second set, based on Model 1130, was more extensive and consisted in the development of several entrances and runs each of identical form as to cross-section and curve of areas but of varying length combined with various lengths of parallel middle body, and these various fore and after bodies so united as to secure two or three models each of identical dimensions, draft and prismatic coefficient but with the position of the parallel middle body varied. These experiments were all carried out for the Emergency Fleet Corporation, and it is by their courtesy that they have been made available for publication today.

A tabulation of the particulars of both sets of models is presented herewith:

PARTICULARS OF MODELS

DESIGN 1107

Displacement Length, 400 Feet; Breadth, 53.66 Feet; Draft, 23.85 Feet; Tested at Draft Ratio of .438

Type	Percentage Parallel Body	Prismatic Coefficient	L.C.B. from Amidships, Percent
Forebody	25.0	.837	42.47
Afterbody—			
A	23.7	.817	41.63
AX	15	.758	39.51
B	15	.790	40.51
BX	9.6	.758	39.33
C	15	.790	40.83
CX	9.6	.758	39.68

DESIGN 1130

Displacement Length, 400 Feet; Breadth, 52.70 Feet; Draft, 23.29 Feet; Tested at Draft Ratio of .435

Type	Percentage Parallel Body	Prismatic Coefficient	L.C.B. from Amidships, Percent
Forebody—			
B	5.84	.709	37.8
C	10.95	.743	38.9
D	16.7	.776	40.1
E	21.19	.810	41.4
F	26.31	.844	42.8
G	31.42	.878	36.3
Afterbody—			
V	4.56	.690	37.2
W	9.5	.724	38.2
X	14.45	.758	39.4
Y	19.38	.791	40.6

The above percentages for position of longitudinal center of buoyancy are based on half length of ship, each type listed being one-half length of vessel. For convenience the parallel body is expressed as a percentage of the full length of the ship.

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November 11, 1920.

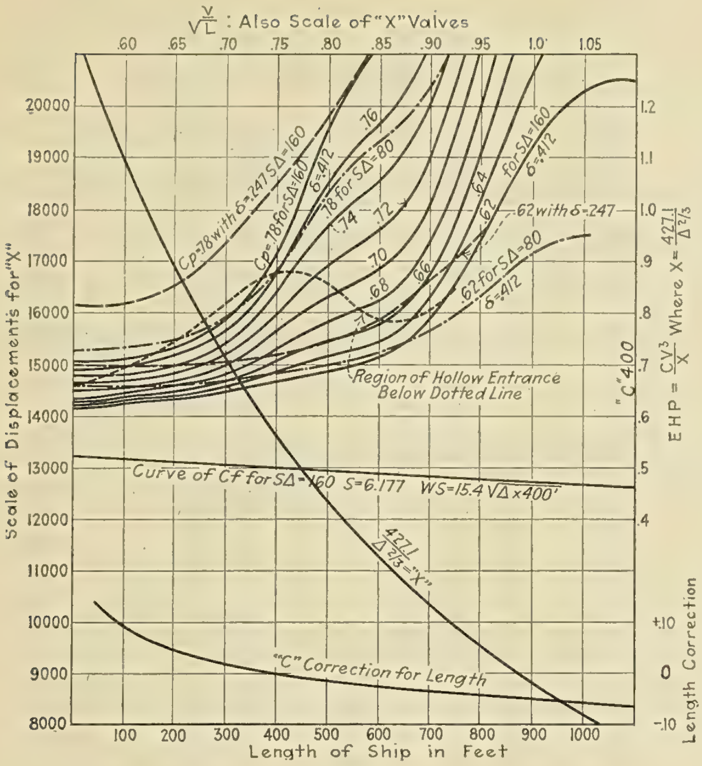


Fig. 2

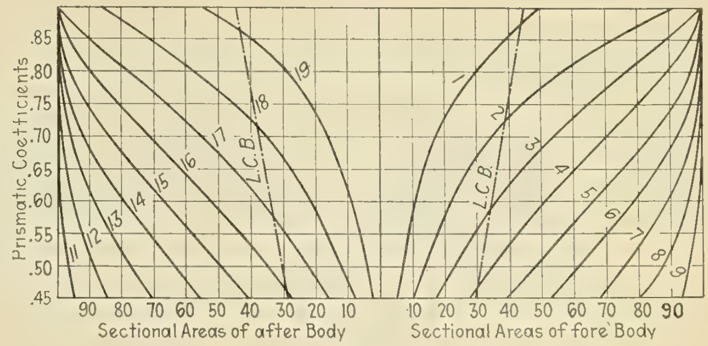


Fig. 3

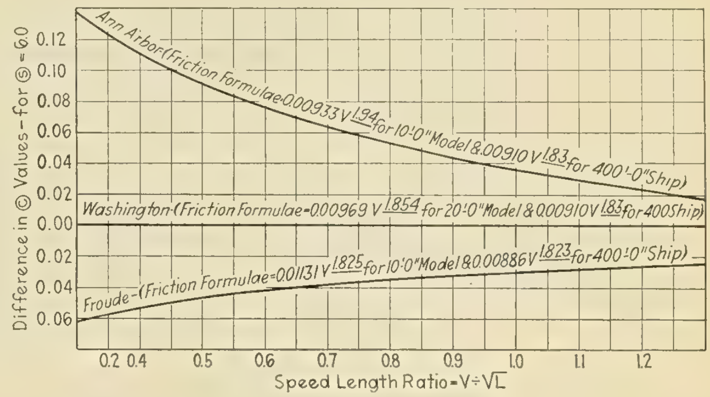


Fig. 4

METHOD OF EXPERIMENT

These tank tests were, in almost every case, carried out at the University of Michigan experimental tank because models used in that tank are of wax and variations in such models are much more readily accomplished and at a much lower cost than is possible with the larger wood models in Washington. At the same time one single screw model was tested at Washington in order to link up the Ann Arbor and Washington tests, and the twin screw model, with and without bossing, was tested in Washington.

It should be noted that the method of extension of experimental model tank tests at Ann Arbor is based on the coefficients of Tideman both for the model and the full-sized ship. These apparently coincide with the results of tests made at the tank some time ago on the frictional resistance of plane surfaces. At the same time it must be pointed out that Tideman's formulae for skin friction, when applied to the full-sized ship, give resistance considerably higher than those attained by the use of the Froude coefficients in the region of speed of cargo ships such as are now under consideration.

METHOD OF PRESENTATION

All the results are presented herewith in the form of C constant curves for a length of 400 feet, wherein

$$C = \frac{427.1 \times E.H.P.}{V^3 \times \Delta^{2/3}},$$

and

$$E.H.P. = \frac{C \times V^3 \times \Delta^{2/3}}{427.1}.$$

This is somewhat of an innovation on this side of the Atlantic, but the advantages of this form of presentation appear to the writer to be so important that he considers it well worth while to draw attention to this system. It should be noted, however, that the speed ratio $\frac{V}{\sqrt{L}}$ used in this paper is the one familiar to our designers, where V equals the speed in knots and L is equal to the actual displacement length of the ship. No use has been made of the speed constant P used largely by Messrs. Baker and Kent because curves on that basis are not so readily comparable for estimating purposes and also because the writer has failed to detect any corroboration of Messrs. Baker and Kent's theory regarding humps and hollows of resistance in the models whose results are presented to you today. It is probable that the theory advanced, that at certain fixed P values resistances are at a maximum, may not hold good where the variation in prismatic coefficient is procured by variation in ratio of entrance to run in conjunction with variation of parallel middle body or possibly the speeds of these ships were too low to prevent the masking of Baker's humps by other more important developments of resistance. I believe that the curves presented in this paper would permit some investigation along these lines.

In order to illustrate this form of presentation and to permit of ready comparison of present results with previous investigations, diagrams of tests showing the effect of location of parallel middle body as carried out by Mr. McEntee and published a couple of years ago are shown on Fig. 1. Fig. 2 gives Taylor's standard series plotted as C curves for 400 feet length, together with C correction curves for other lengths, and a curve of $\frac{427.1}{\Delta^{2/3}}$ designated X, by means of which the effective horsepower may be immediately arrived at from one diagram. Areas of the various sections at different prismatic coefficients for Taylor's series are shown on Fig. 3 in order that the form of Taylor's models may more readily be compared with the series here presented.

In addition a diagram, Fig. 4, is presented showing the theoretical difference between tank tests as extended by the various coefficients of friction now in use at Ann Arbor, Washington and in England. These curves are based on the assumption that the actual friction of a model of unit length at the three tanks is identical, but careful comparisons between tests of the same model made at Ann Arbor and at

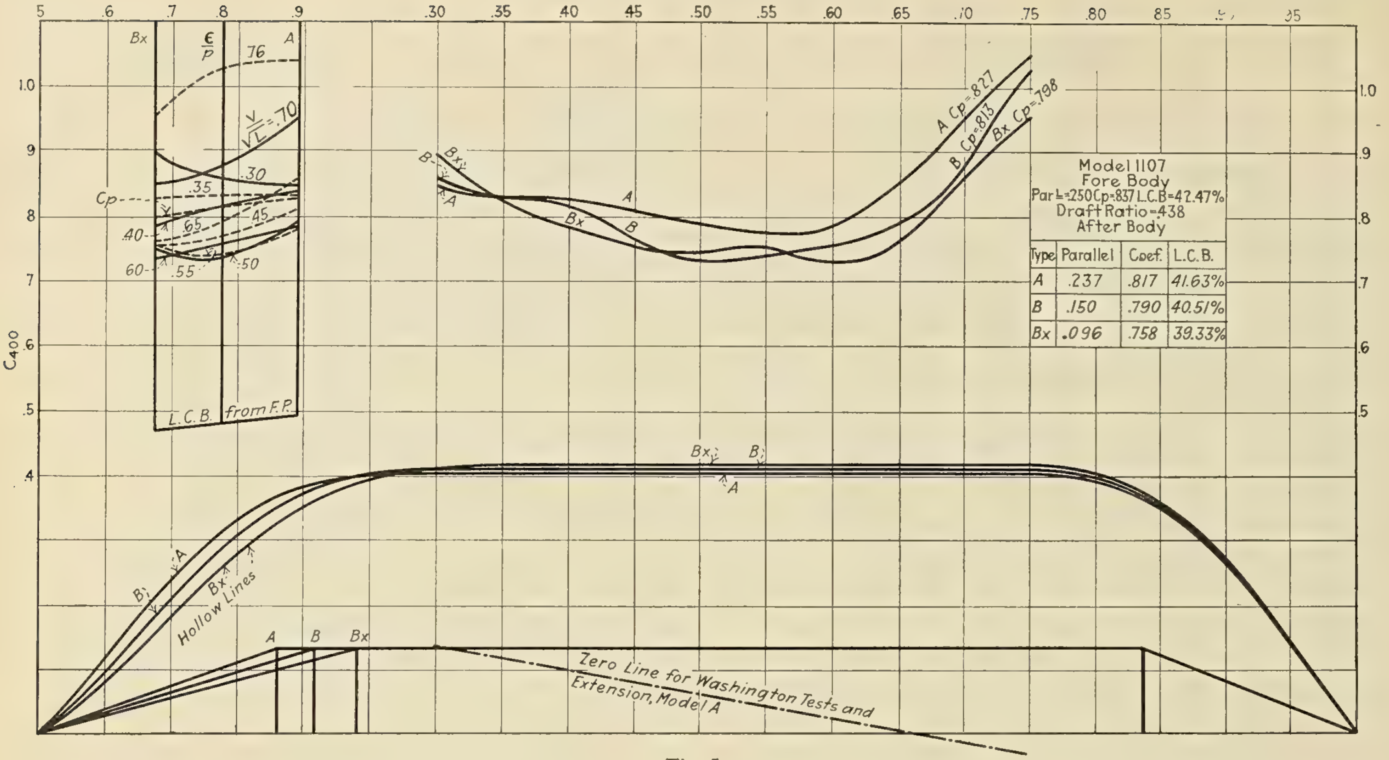


Fig. 5

Washington seem to indicate that the Washington resistances, particularly for models of high displacement, run somewhat higher than can be anticipated from these curves. Whether this is due to some interference in the stream lines, due to the cross-section of the Washington model being larger in proportion to the section of the tank than is the case at Ann Arbor, or whether it is due to elements of eddy making not yet properly understood or simply to the actual difference in the surface of the models is yet unknown to the writer.

Because of the uncertainty of what is the true frictional resistance of these models the method adopted at Ann Arbor of using Tideman's coefficients has been accepted for use by the writer in extending present results and we thus secure very conservative resistances.

That the Ann Arbor estimates of effective horsepower for slow speed cargo steamers appear to be very close to the actual effective horsepower required for the ship has been demonstrated in quite a large number of cases and I think this might be explained by Baker's theory of the augmentation of frictional resistance in full ships due to the nature of the wave profile and the resultant acceleration of velocity of the water at the surface of the vessel, the magnitude of this increase in resistance being roughly equal to the difference between effective horsepowers calculated by Froude's method and effective horsepowers calculated by the Tideman formulæ. I have not been able to ascertain whether Baker has applied this correction to his model resistances as recommended in his book* before compiling his *C* constants given in his recent papers.

* "Ship Form, Resistance, and Screw Propulsion," paragraph 10.

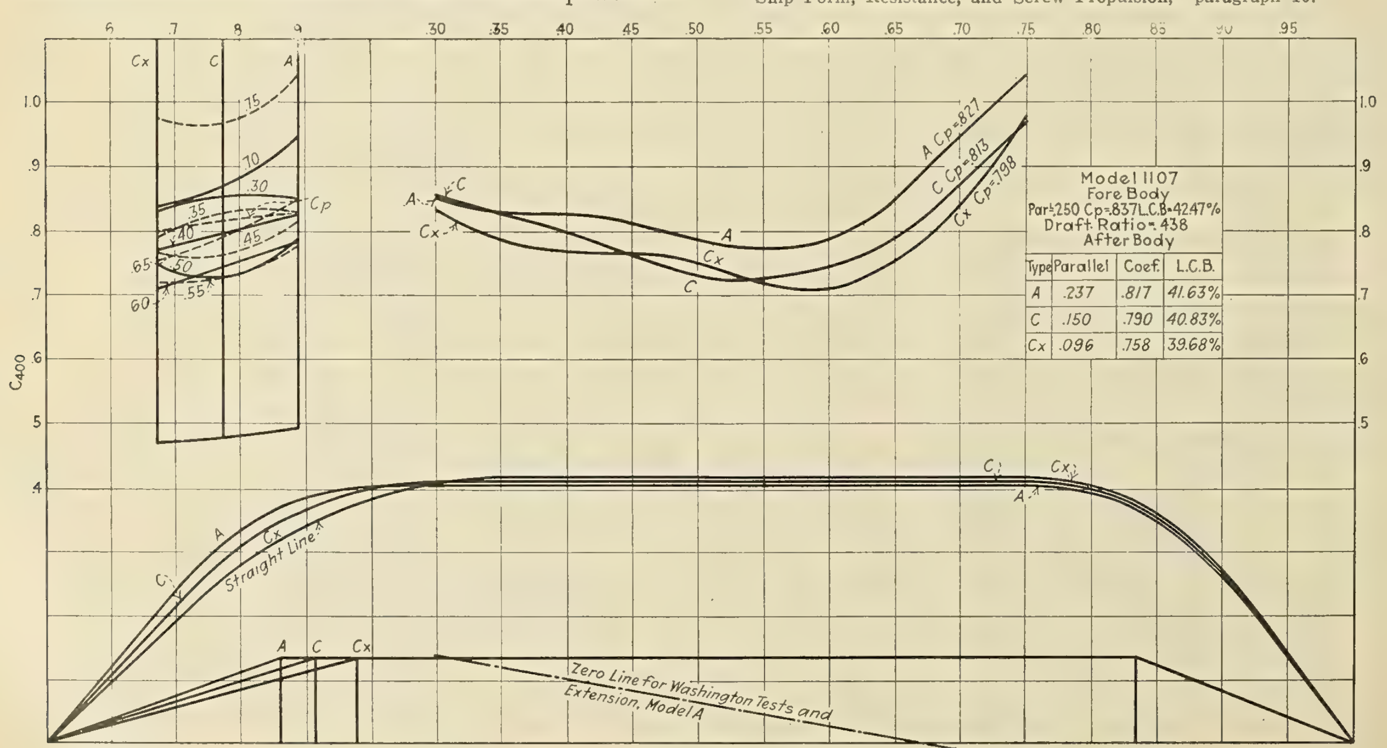


Fig. 6

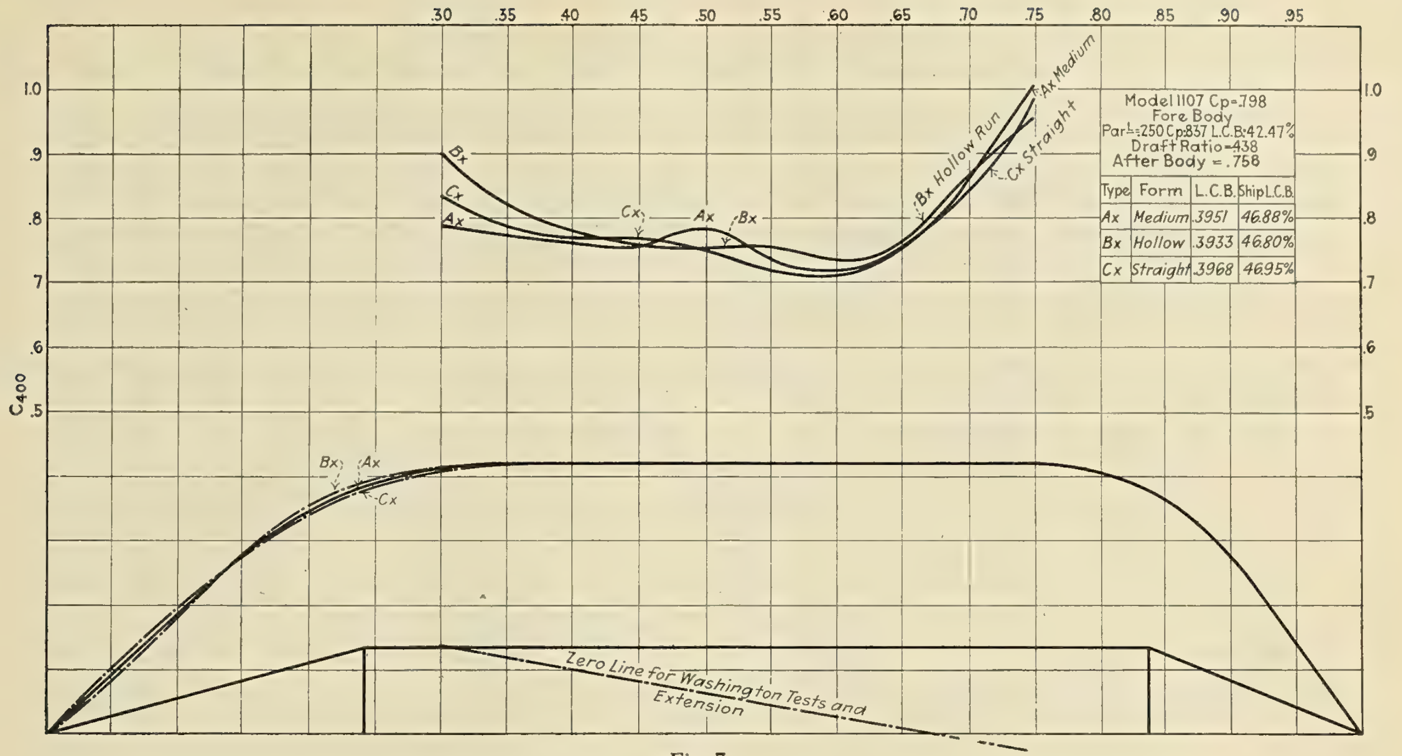


Fig. 7

All results given herewith have been standardized for a water temperature of 70 degrees F.

Those who have prepared the lines of vessels with parallel body will recognize that it is difficult to state definitely the point where entrance and parallel body combine and that this point may be varied very considerably with an extremely small variation in the form of the ship. For this reason it was found necessary, in order to make comparisons fair, that an analysis length of entrance and run should be devised. At the same time it has been demonstrated repeatedly that the form of midship section within the range adopted in cargo ships does not make any material difference in the resistance of the ship, and as it was necessary to standardize draft as well as form, the following method was employed. A slight modification of the block model, generally known as Dr. Kirk's analysis, was adopted wherein the breadth of the model was maintained equal to the breadth of the ship and modification was made in the draft, this being such that the cross-sectional area of the model is the same as the midship section of the ship. This gives us an analysis draft equal to the product of draft of the vessel and coefficient of midship sectional area, and the angles of entrance and run are such that the plan of the block model contains exactly the same area as a curve of sectional areas of the ship. The fraction of the length of the vessel which would consist of entrance is equal to 1 minus prismatic coefficient of fore body. The fraction of the length of the vessel represented by parallel middle body is equal to twice the prismatic coefficient of the whole ship minus 1 and the fraction of length of run is, of course, equal to 1 minus prismatic coefficient of after body. This block model, which is bounded by straight lines and contains a volume equal to the displacement of the ship, indicates the mean angle of entrance and mean angle of run of the vessel as well as the analysis length of entrance and run; examples are shown on Figs. 5, 6, 7 and 9.

In order to distinguish this analysis entrance from the ordinary length of entrance the Greek letter ϵ has been used and for run the letter ρ has been adopted, the parallel middle body being represented by π and the ratio of entrance to run has been expressed as ϵ/ρ throughout the paper. The analysis draft when divided by breadth gives the analysis draft ratio δ. (See Appendix I.)

SERIES 1107

Model 1107 is that of an ordinary cargo ship with plumb stem and counter stern raised well above the load waterline and the length for displacement was taken as 98 percent of the length between perpendiculars. The original model designated *A* had a curve of areas as shown in the lower part of Figs. 5 and 6 and was tested both at Washington and at Ann Arbor. The Ann Arbor model was then fined in two steps as shown, the resulting resistance curves being also shown. Cross curves of *C* values at different speeds are given in the left hand end of each diagram plotted on ϵ/ρ ratios, and a zero line which required a certain amount of fairing has been shown indicating the actual difference in *C* value for model *A* as tested and extended at Washington and at Ann Arbor. In Fig. 6 the two modifications designated *C* and *CX* are identical with *B* and *BX* in Fig. 5 as regards prismatic coefficient, but are straight in form and consequently easier at the after shoulder than the *B* curves. It will be noticed that the straight form generally produces the lower resistances but has not eliminated a curious crossing in the *C* curves around the region of a speed ratio of 0.50.

A third comparison of resistances is shown in Fig. 7, *BX* and *CX* being plotted together with an intermediate curve identical in form with the original curve of areas *A*, but of the same prismatic coefficient as *BX* and *CX*. Special attention must be drawn to the development of the hump in these three

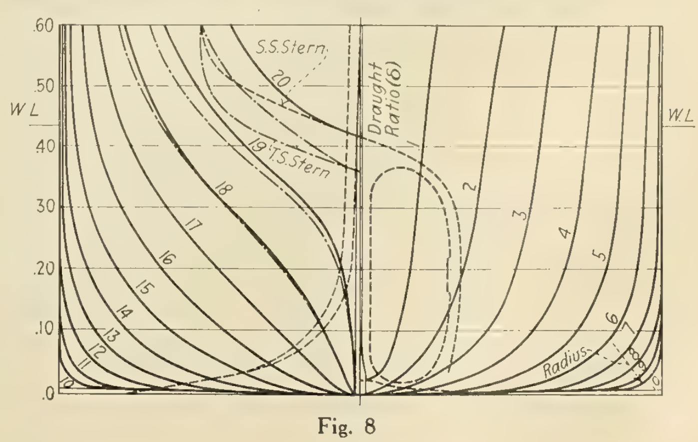
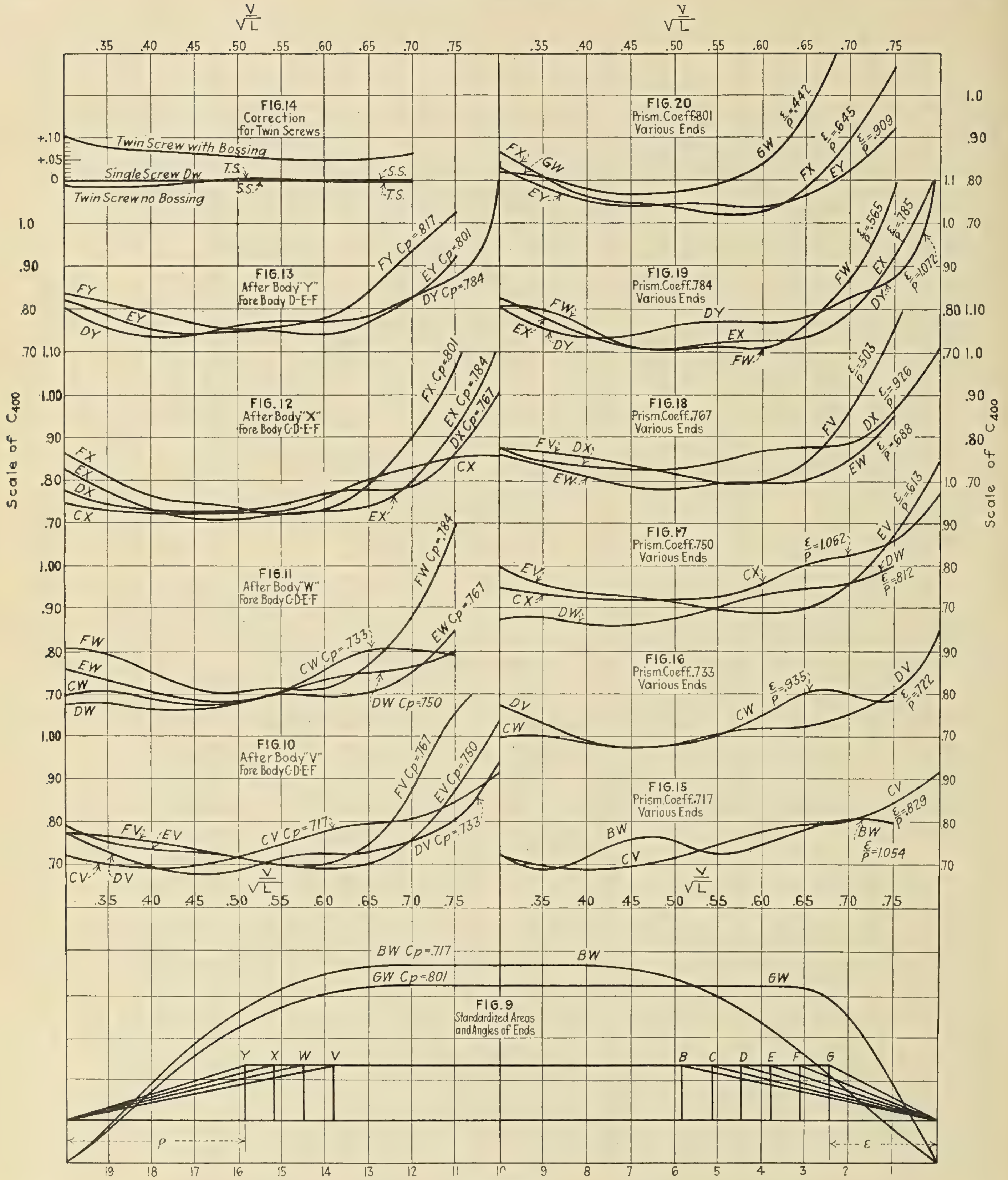


Fig. 8



Figs. 9-20

models, all of identical prismatic coefficients, and the emphatic increase in resistance which *AX* shows compared with *BX* and *CX* at a speed corresponding to 10 knots for a 400-foot ship cannot be lost sight of because this illustrates a danger to which naval architects are exposed in departing from known models from which resistances are estimated.

Series 1130

Series 1130 represents a model of a single screw cargo ship as shown on Fig. 8, which gives cross-sections of the entrance and run, the parallel body being omitted. This model has a very small cruiser stern which, at the draft reported herewith, was only sufficient to carry the lines and curve of areas to the aft perpendicular. Generally the aperture in a single screw steamer makes the displacement length 2 percent or 3 percent less than the length between perpendiculars. In this series the various combinations of entrance and run produced in all 18 models for the single screw type, and there was a twin screw model of *DW* modified, both with and without bossing. The twin screw model was tested at Wash-

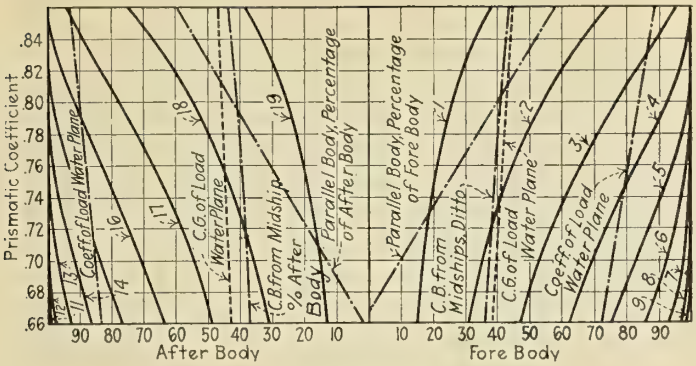


Fig. 21

ington only and the *DW* was tested both at Washington and Ann Arbor. All these models were tested at draft ratios of 0.489, 0.435, 0.351, 0.261, with the exception of the twin screw model, where the displacements were held identical and the draft ratio was therefore very slightly reduced, but in order to keep this paper within reasonable compass the results at $\delta = 0.435$ only are presented herewith.

Fig. 9 indicates the angles of entrance and run corresponding to these models, and standard curves of areas of the two

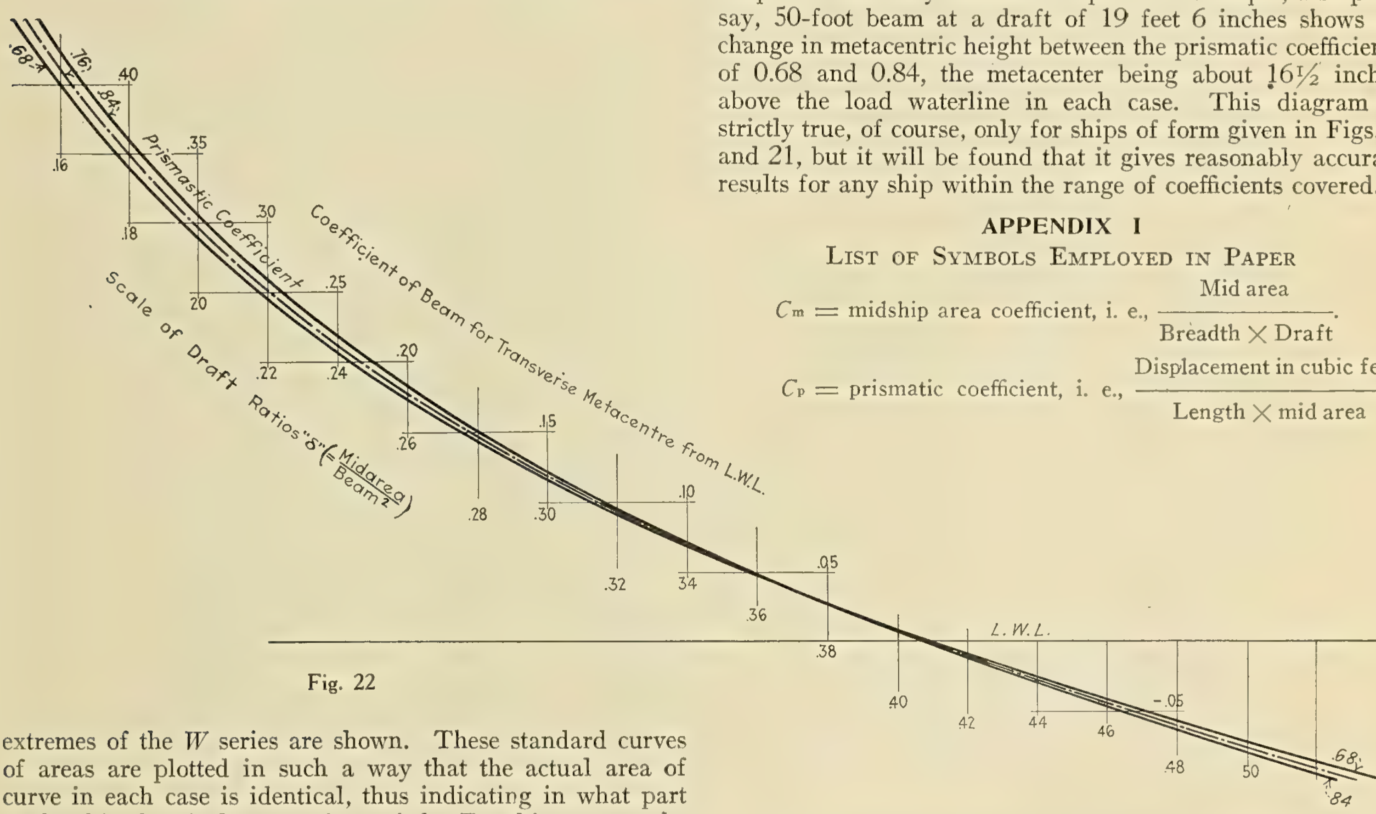


Fig. 22

extremes of the *W* series are shown. These standard curves of areas are plotted in such a way that the actual area of curve in each case is identical, thus indicating in what part of the ship the displacement is carried. For this purpose the midship area is laid out equal to 100 divided by three times the prismatic coefficient. In Figs. 10, 11, 12 and 13 these resistance curves are presented where each after body is shown with three or four different fore bodies, one or two curves having been left out of some of the diagrams to prevent confusion. Resistance curves could equally well be assembled with identical fore body and varying after body, and the student will find advantage in laying them out this way.

In Figs. 15 to 20 the curves of resistance shown in Figs. 8 to 11 are assembled in accordance with the prismatic coefficient, and these curves will probably prove of more use to anyone desiring to utilize this series of experiments for design purposes. Cross curves of each of these diagrams can also be plotted similar to those shown in Figs. 4 and 5, and if this is done it becomes a simple matter to select the best e/p ratio for any particular speed.

Fig. 14 shows the comparison between single screw vessels and a ship of similar lines to *DW* with the aperture filled in as indicated by the dotted lines on Fig. 8, and the resistance of the twin screw bossing for this model is also given as indicating the augmentation of resistance which is produced on twin screw ships.

In order to fully utilize these results in the design of a cargo ship, Fig. 21 was prepared. This diagram is laid off on prismatic coefficients, both for fore body and after body, which are independent of one another, and when the necessary prismatic coefficient of each end is chosen from one of the figures (15 to 20) it is immediately possible to lay off a curve of areas for the prismatic coefficient of each end from Fig. 21. The amount of parallel middle body is also shown so that the entrance and run may be divided up equally and the sections made to correspond to Fig. 8. As it is necessary, usually, in designing a ship to have a fairly accurate knowledge of the height of transverse metacenter at an early stage of the work, a new diagram, Fig. 22, has been devised by the writer. It gives the location of the transverse metacenter from the load waterline as a coefficient of the beam of the ship at various draft ratios and at three prismatic coefficients, but it is noteworthy that the prismatic coefficient has an extremely small influence on the stability at draft ratios such as are adopted in ordinary merchant ships. For example, a ship of, say, 50-foot beam at a draft of 19 feet 6 inches shows no change in metacentric height between the prismatic coefficients of 0.68 and 0.84, the metacenter being about 16½ inches above the load waterline in each case. This diagram is strictly true, of course, only for ships of form given in Figs. 8 and 21, but it will be found that it gives reasonably accurate results for any ship within the range of coefficients covered.

APPENDIX I

List of Symbols Employed in Paper

C_m = midship area coefficient, i. e., $\dfrac{\text{Mid area}}{\text{Breadth} \times \text{Draft}}$.

C_p = prismatic coefficient, i. e., $\dfrac{\text{Displacement in cubic feet}}{\text{Length} \times \text{mid area}}$.

C = Froude's resistance constant = $\dfrac{E.H.P. \times 427.1}{V^3 \times \Delta^{2/3}}$.

C_f = frictional resistance constant = $\dfrac{F.H.P. \times 427.1}{V^3 \times \Delta^{2/3}}$.

S = wetted surface constant = $\dfrac{W.S. \times .09346}{\Delta^{2/3}}$.

$W.S.$ = wetted surface in square feet $\left(\dfrac{(S)\ \Delta^{2/3}}{.09346}\right)$

V = speed in knots.

$S\Delta$ = standard displacement = $\dfrac{\text{Displacement tons}}{\left(\dfrac{L}{100}\right)^3}$.

L.C.B. = longitudinal center of buoyancy.

E.H.P. = effective horsepower $\left(\frac{CV^3 \Delta^{2/3}}{427.1}\right)$

Δ = displacement in tons of 35 cubic feet (salt water).

δ = draft ratio, i. e., $\frac{\text{Mid area}}{\text{Beam}^2} = \frac{\text{Draft} \times C_m}{\text{Beam}}$.

ϵ = analysis length of entrance = 1 minus prismatic coefficient of fore body.

ρ = analysis length of run = 1 minus prismatic coefficient of after body.

π = analysis length of parallel body = twice prismatic coefficient of ship — 1.

APPENDIX II

Two examples of the use of this paper are herewith given in detail:

(*a*) Find the effective horsepower for the following ship at 11.0 knots. Length between perpendiculars and waterline, 420.0 feet; breadth, 53.0 feet; draft, 26.5 feet; mid area coefficient, .987; displacement, 13,000 tons; $\frac{\epsilon}{\rho} = 0.768$.

$$\text{Block coefficient} = \frac{13{,}000 \times 35}{420 \times 53 \times 26.5} = .7713.$$

$$\text{Prismatic coefficient} = C_p = \frac{.771}{.987} = .781.$$

$$\delta = \frac{26.5 \times .987}{53} = .4935.$$

$$\frac{V}{\sqrt{L}} = \frac{11}{\sqrt{420}} = .537.$$

From Fig. 19 *C* for *EX* = .720; for C_p = .784. $\frac{\epsilon}{\rho}$ = .755.

18 *C* for *EW* = .691; for C_p = .767. $\frac{\epsilon}{\rho}$ = .688.

Therefore, by interpolation for proposed ship with

	δ = .435	*C* = .715
and with	δ = .493	*C* = .704
Length correction		— .003
C for Ann Arbor		.701
C for Washington		.651

And effective horsepower (Washington) =

$$\frac{.651 \times 11^3 \times 13{,}000^{2/3}}{427.1} = 1{,}120.9.$$

The actual horsepower of above ship as tested at Washington was 1,122.

(*b*) What are the best proportions, etc., of a ship of 550 feet length and 21,720 tons displacement for a speed of 16 knots, and estimate effective horsepower.

$\frac{V}{\sqrt{L}} = \frac{16}{\sqrt{550}} = .682$ and by inspection .767 C_p is the highest C_p possible.

$$\text{Then mid area} = \frac{21{,}720 \times 35}{550 \times .767} = 1{,}802.$$

For $\delta = .435B$ = 64.4 feet and draft with C_m = .98 = 28.58.

From cross curves of Fig. 18 $\frac{\epsilon}{\rho}$ should = .70 and *C* = .730.

$$\epsilon + \rho = 1.00 - \pi = 1.00 - .534 = .466.$$

$$\epsilon = \frac{.70}{1.0 + .70} \times .466 = .1919.$$

$$\rho = \frac{1.0}{1.7} \times .466 = .2741.$$

Therefore fore body C_p = 1.0 — .192 = .808; after body C_p = .726.

Thus the vessel should be 550 feet × 64 feet 5 inches × 28 feet 7 inches draft.

C_p of ship = .767; C_p of fore body = .808; C_p of after body = .726; C_m = .980; *L.C.B.* = .463 = 254.7 feet aft of forward perpendicular.

Height of transverse metacenter = .023*B* below *WL* = 27.1 feet above base.

$$E.H.P. = \frac{CV^3 \Delta^{2/3}}{427.1}. \quad C = .730 - .018 \text{ (length correction, Fig. 2)}.$$

$$E.H.P. = \frac{.712 \times 4{,}096}{.546} = 5{,}341.$$

This power would be reduced by increase of draft until δ = .485, at which effective horsepower = 5,220, but there would also be a reduction in *KM* and stability.

If it is necessary to locate the longitudinal center of buoyancy differently it is possible from the diagrams to estimate the increase in horsepower due to this. If longitudinal center of buoyancy were moved 15 feet farther aft the power would be increased by 200.

Laying Up Great Lakes Vessels for the Winter*

From November to March each year traffic on the Great Lakes must stop, for when the ice begins to form navigation becomes impossible. The lake steamers, ranging from 5,000 to 12,000 tons, are then laid up for the winter at their home ports.

During this idle period great care must be taken that everything on the vessels is in order, for when the open season again arrives no time must be lost on engine and hull repairs. Boilers, engines and various auxiliary machinery on board must be protected against corrosion and rust. To this end the external parts of the main engines are covered with a heavy bodied oil or with a mixture of white lead and tallow, as are also the external parts of the auxiliaries. The internal parts of the main engine cylinders and valves are protected with a coating of heavy bodied oil of such a character that it will stick to all of the parts and "stay put." The boilers and all piping throughout the ships are emptied to prevent the possibility of burst pipes from freezing, and the vessels are then placed in charge of a shipkeeper.

Another important item is the protection of the sea cocks and valves, for if freezing takes place and sea cocks have not been protected, they are sure to be burst, with rather expensive results. By protecting these parts with the correct grade of oil, the propelling machinery is ready and in condition when the spring arrives, and the ships are ready to begin their work for the season.

Vessels Built for the Green Star Line

Five 9,600 deadweight ton cargo vessels of the *Arcturus* type have been built by the G. M. Standifer Construction Corporation, Vancouver, Wash., for the Green Star Steamship Company, New York. The vessels are 402 feet 6 inches between perpendiculars and 53 feet molded beam. The depth to the shelter deck is 34 feet 6 inches and the molded depth to the lower deck is 23 feet 6 inches. Propulsion is by a set of triple expansion 3,000-horsepower engines, placed amidships, supplied with steam by three oil burning Scotch boilers. The officers' quarters are under the deck house forward on the boat deck, while two deck houses are arranged amidships on the bridge deck. Quarters for the crew are located aft on the poop deck.

* From the October issue of the *Compass*, published by the Vacuum Oil Company, New York.

Fuel Oil for Steamers

Grades of Oil Available for Merchant Vessels and Their Use

BY C. H. PEABODY, DR. ENG.

IN the old days of the galleys, biremes, and triremes, a favorite trick was to get the enemy to row around until he was tired and then pounce on him; today a fleet that has made a forced voyage and worn out the firemen and coal passers would be at a like disadvantage. When the *Esmeralda* in the hands of immigrants came up the Pacific coast the *Charleston* was sent to capture her, for though a band of insurgents ashore may be patriots, the crew that have seized a ship are pirates. However, the question was not brought to issue because the *Charleston* could not get coal into the fireroom fast enough.

The ideal fuel for a warship is a distillate such as has been used on our destroyers, as white and limpid as water and with a high flash point, so that there is no danger in storage or handling. But with the development of hot bulb and Diesel engines there is little chance for so good a fuel on steamers. Yet for warships the oil should flow freely and pump and atomize without heating. Not that heating oil to diminish viscosity is either hazardous or unduly difficult, but that heating introduces complexity.

Fuel Oil for Merchant Vessels

The case for the merchant marine is different. The only fuel available is refuse that cannot be distilled or refined. Most of it is the asphaltic base that is found in the Texan, Mexican and South American petroleums. Usually the oil must be heated to pump it and again to atomize it; the latter is of small moment, but provision of steam pipes in oil tanks is troublesome, though it has been found that it is not necessary to heat the whole ocean but that it is sufficient to heat the oil near the intake to the pumps.

Like all problems in business economy, the determination of the saving from the use of oil is involved and complicated; perhaps it would be better that the problem should be stated in terms of relative cost of coal and oil for like economical results. A convenient though crude rule is to say that one can afford to pay twice as many dollars per ton of coal as cents per gallon of oil.

Economy of Oil Burning

Some of the elements that enter into the question are bunker capacity, cost of fitting, and the crew and their maintenance. Now coal is broken and does not stow well, so that though oil is lighter there is a direct saving of 10 percent in favor of oil; but the oil makes more steam per pound, so that there is a saving of 35 percent in bunker capacity. The value of this saving is influenced by freight rates. An offset is the cost of fittings, which are much more expensive for oil, and this item goes into the capitalization.

For America, the influence of oil fuel on the size and personnel of the crew is most important; it may be a determining factor. In the first place, the number of fireroom crew may be reduced by half or two-thirds, and a higher class of men can be secured; indeed, a higher class is demanded. There will be some saving in wages and a saving in maintenance, proportional to the number, but the real question is the possibility of getting American citizens for firemen. On coal burners the question is where to find men of any nationality who are willing to endure the inferno of the fireroom.

With the introduction of oil fuel comes a demand for greater intelligence and skill on the part of engineers and firemen, for oil can be burned with all sorts of results, both good and bad. There is range enough in burning coal between results from competent and incompetent crews, but there is a limit, for if the fire gets into a really bad condition it may go out, while oil will just keep on burning so long as it is supplied to the furnaces.

Methods of Atomizing the Oil

There are three methods of atomizing the oil: by the use of steam, by the use of compressed air or mechanical atomizers. For shore stations, steam atomizers have long been used with entire satisfaction; about 2 percent of the steam generated in the boilers is used by the atomizers, but as a boiler efficiency of more than 80 percent can be maintained, we cannot expect much better.

At sea the waste of so much fresh water is undesirable, and so it was first proposed to use compressed air, and with the proposal was the idea that the air used in the atomizer would so aid combustion as to improve economy, but there was nothing in it. The cost and trouble of compressing air precludes the use of this method and there is no reason for further consideration of compressed air because mechanical atomizers are entirely satisfactory.

There are a large number of satisfactory mechanical atomizers, all of which work by ejecting oil under a high pressure with a whirling motion. The desiderata are simplicity of construction and ease of cleaning. Spare atomizers are carried so that any one may be readily replaced. They are made in all sizes from those adapted to launch boilers to those delivering the astounding quantity of 2,000 pounds of oil per hour. Such burners have given a boiler efficiency of 80 percent, leaving little or no chance for improvement by any method. Using such burners the enormous horsepower of 180,000 for our new battle cruisers can be obtained by using eighty or a hundred burners.

The one defect of the mechanical atomizer has been that when the flow of oil was reduced to half capacity the whirling velocity was not enough to properly atomize the oil. Recent improvements have succeeded in maintaining the velocity when the flow is reduced to 10 percent of the normal, and, consequently, burners can work under all conditions of service.

It is exceedingly important that good combustion should be maintained; too much air may act mainly to heat the atmosphere. Too little air is worse because it not only spoils the efficiency but soots up the boiler, which is always bad and is anathema for watertube boilers.

A method in common use is to watch the funnel; when there is a slight haze, the combustion is about right. Another method is to watch the fire through observation holes. Certainty of best results can only be obtained by gas analyses to determine existence of carbon monoxide or excess of air. This is a new demand on the operating engineer, though familiar enough to the engineering expert.

Oil Piping

The oil piping must be above suspicion, especially in or near the engine room, because leakage is extremely dangerous. The navy, partly for the sake of lightness, uses drawn steel pipes with flanges expanded on; for merchant service, welded pipes with screwed flanges are sufficient. After all, the real demand is for good workmanship to make a tight job. And where there is a good job there should be eternal vigilance to detect the first signs of leakage no matter where it may occur.

Since the oil is viscid, pipes and valves must be generous; a suction velocity of 20 feet a minute being usual, with a discharge velocity of 100 feet per minute. Heating coils are provided around the suction in the oil tanks and heaters are supplied in or near the fireroom for the atomizers. There are usually two heaters, one being a spare; or, better, there may be three, with two in service and the third for a spare. The early heaters had steam coils, but the present practice is the reverse with oil in the coils. The oil should not be heated above the open flash point, although there appears no great danger, since the oil is under pressure in the pipe until it passes the atomizer.

Method of Starting Burners

Boilers having steam atomizers can be started by building a wood fire under one of the boilers; if the plant is of considerable size there may be a donkey boiler that can be started with wood and thus get up steam for the pumps and atomizers. At sea, where viscous oil is used with mechanical atomizers, there will always be a donkey boiler and there must be some sure and easy way of getting steam on it. A conservative way is to have means for burning coal; at any rate, for starting. Any seagoing engineer will appreciate having a banked fire which needs only to be opened up when steam is needed. There are devices in the market for burning oil in an open pan or trough. Even when mechanical atomizers are used under the main boilers it is convenient to have steam atomizers for the donkey boiler, which arrangement should not make too much demand on the fresh water supply, or on the distilling apparatus when one is supplied. If, however, the donkey boiler has a mechanical atomizer, there may be a hand pump to work it while getting up steam.

As for safety, an oil with a low flash point in properly constructed tanks is safer than coal, for there is no chance of spontaneous combustion. It would be difficult to set such a tank on fire unless an external conflagration is strong enough to heat it up toward its flash point. The tank must, of course, be properly riveted and have adequate bulkheads and expansion trunks and swash plates should be provided when necessary, all of which is ordinary construction by a good shipbuilding company. The item of construction demanding greatest care and good workmanship is the oil piping, as has already been said.

With the present demand for gasoline, there is little occasion for considering the use of raw oil for fuel at sea; the gasoline is pretty sure to be topped off if no further refining of the oil is done. Perhaps tankers carrying crude oil will be arranged to burn that oil under the boiler; in such case safety can be had only by exercising eternal vigilance, for crude oil with all the lighter components in it is a most dangerous material; it is very much worse than gasoline. Should any combination of circumstances lead to the use of crude oil on a freighter, then all the precautions and methods of construction used on crude oil tankers to guard against conflagration and explosion must be provided and the engineers and firemen must be properly instructed and cautioned.

Judging the Quality of Fuel Oil

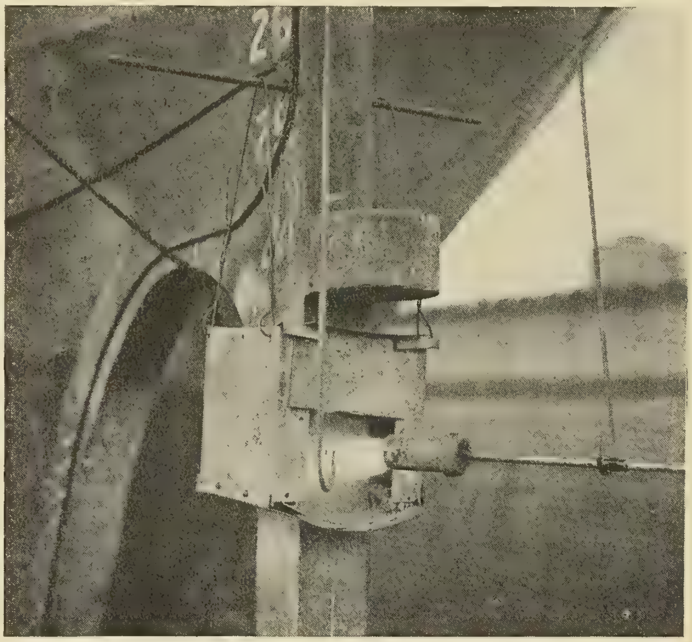
In judging the quality of fuel oil, three properties are considered: the viscosity, density and the heat of combustion. Since the convenience or even the possibility of pumping and atomizing depends on the viscosity, it is the first and most important of the three. Unfortunately, there are three or four different kinds of viscometers; they differ so much that it is difficult to interpret one in terms of another. Probably any one could be made to serve if it were standardized and universally used. It is doubly unfortunate that there is a tendency to solve the problem by using some entirely different method. However, an expert may familiarize himself with all and only an expert can be expected to get results.

There is some relation between density and viscosity, though it does not appear to be well known and undoubtedly varies with the composition of the oil. This is probably the reason why the determination of density is important. The usual way is to determine density by a hydrometer using the Baume scale, though the viscosity of oil makes it unsatisfactory; the advantage is that any intelligent person can learn how to use that instrument. Probably an expert could make direct determinations of the specific gravity compared with water by the use of the specific gravity bottle.

The heat of combustion is determined in the usual method for fuels, and must be done by a specialist if reliable results are to be had. Incidentally, it may be said that sulphur in the proportion found in petroleum is not troublesome when the oil is used for making steam. There is less variation in the total heats of various oils than is found in the endless varieties of coal, anthracite, bituminous and lignite, not to mention intermediate grades. Nevertheless, oil should be sold on its capacity for developing heat and should be guaranteed for viscosity. Since oil companies must have a staff of experts, the most economical way is to have all determinations of properties made by such experts and guaranteed by the company.

Stern Frame Straightened in Dry Dock

When the steamship *S. B. Hunt* was docked for repairs by the Morse Dry Dock & Repair Company, Brooklyn, N. Y., recently it was found that the stern frame was buckled and curled and the rudder pintle bushings worn out. To follow the ordinary procedure in repairing this damage meant that the stern frame be disconnected three or four



Heating Stern Post on Steamship *S. B. Hunt*

plates taken out, and the stern frame removed; then the sending of the piece to the shops to be faired, machined and later to be replaced.

Such procedure was waived; it meant a loss of considerable time, much more labor and increased costs on that particular job. It was decided that the frame could be straightened without its being detached from the ship, and an all-night gang was assigned to the work. They built heating boxes, used kerosene blowers, coke filling, differential pulleys and hydraulic jacks. Heats were applied with pressure and the buckled stern frame was straightened.

It has been estimated that the actual work saved the shipowner $25,000, to say nothing of the time his vessel would have been laid up under the ordinary routine—probably from 25 to 30 days.

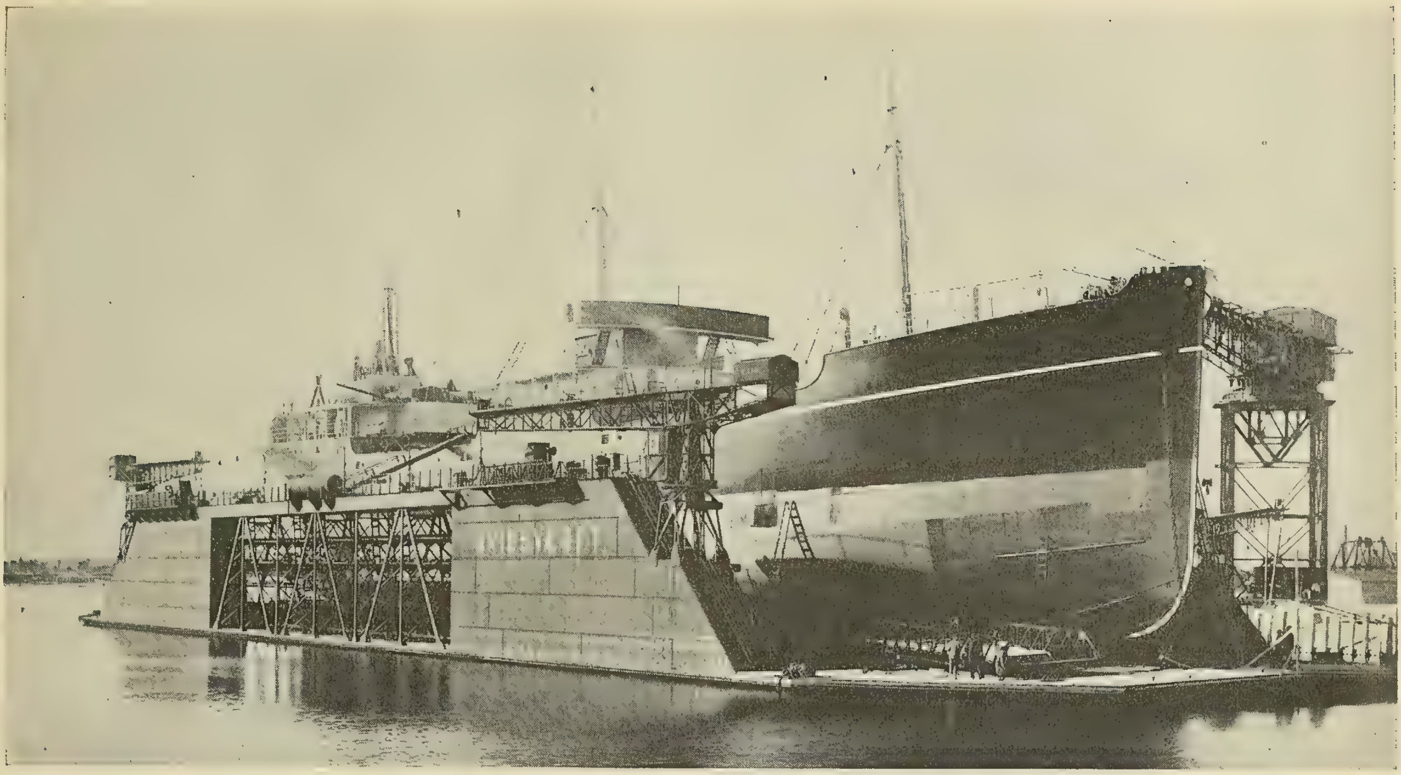


Fig. 1.—The Motor Tank Ship *Mexico*, 6,000 Tons, Built for the East Asiatic Company. She is Equipped with Two Holeby Four Cycle Diesel Engines of 800 Indicated Horsepower Each

Conversion of Steamers to Motor Craft

British Coal Strike Boosts Development of Motorships—Number of Existing Steamers to Be Converted into Motor Vessels

BY OUR SPECIAL LONDON CORRESPONDENT

By a curious coincidence, just at the outbreak of the coal strike a tramp steamer that had been converted to a motor vessel in Germany called at a British port on her maiden voyage and created an immense amount of interest among British shipowners. This vessel was the *Augusta* belonging to the Banck Line, of Stockholm, and was a typical tramp steamer. Owing to the excessive price of coal and the difficulty of obtaining it, the owners decided to install a 1,200 indicated horsepower (800 brake horsepower) Sulzer engine instead of the same steam engine of approximately the same shaft horsepower.

After the conversion had been carried out it was found that the consumption, which with coal had been 18 tons per day, was reduced to four tons of oil, the average saving on the fuel bill being approximately 50 percent. In addition, the *Augusta,* which as a steamer carried approximately 5,000 tons of cargo, is now able to load 5,300 tons on account of the smaller space occupied by the machinery.

Two Cycle Engine in Favor

British engineers are tending towards the two cycle type of Diesel engine in spite of the success of the four cycle principle, and the installation in the *Augusta* represents the latest trend in two cycle design. The power of 800 brake horsepower is developed in four cylinders and the usual Sulzer system of scavenging by means of two sets of ports in the cylinder is adopted. A novel feature is the control of the engine from the upper platform instead of from the engine floor level, which is the usual arrangement. The main object of this is to eliminate as many levers and shafts as possible, for the control wheel acts directly upon various shafts. Since the conversion the machinery of the *Augusta* has run without the least trouble, which is a good augury for the many vessels now being built in Great Britain in which machinery of the same class is being installed.

The novel Cammellaird-Fullagar engine which aroused so much comment in America is exceedingly well thought of in England, and the operation of the first set in the 500-ton coasting vessel *Fullagar* appears to have pleased the owners. The engine is of 500 horsepower, and since the vessel was commissioned a few months ago she has run 10,000 miles with complete success. The power is, however, obviously too much for the size of the boat, and the owners have therefore ordered a second engine of the same power, and when completed the two sets (the new engine and the one from the *Fullagar*) will be installed in a new 4,000-horsepower motorship now under construction for the Brocklebank Line. A smaller motor will then be installed in the *Fullagar*.

Cammellaird-Fullagar Engine Proves Reliable

This fact would seem to indicate that the new engine has proved its reliability and that it is likely to become a sound commercial proposition. However, it should be pointed out that in the present engine some of the main difficulties which will be met with in opposed piston motors have not yet been encountered. For instance, as is well known, the liner in an opposed piston engine is a most vulnerable feature, but difficulties are only likely to be encountered in fairly large sizes, say in diameters greater than 25 inches. No Cammellaird-Fullagar engines with cylinders of this size have yet been built, so that it would be as well to defer an ultimate opinion regarding the suitability of this motor for exceedingly high powers until further experience has been gained. This is not in the least to suggest that insuperable difficulties will be met, but merely to point out that satisfactory experience with small engines does not necessarily imply that immediate and complete success will be attained with motors of several thousand horsepower.

New Orders Placed for Motorships

There is no depression in the motorship building industry in Great Britain, and many new orders have recently been placed. The British Tanker Company, Ltd., has contracted with William Denny and Brothers, Dumbarton, for a 10,000-ton tanker, 425 feet in length between the perpendiculars, with a beam of 56 feet 8 inches and a molded depth of 33 feet. In this vessel two 1,350 brake horsepower four cylinder Sulzer engines will be installed, but although Dennys are licensees for Sulzer motors, no doubt they will be mainly built at the Swiss works.

The Royal Netherlands Steamship Company has ordered a 2,200-ton vessel fitted with an 850 brake horsepower Werkspoor motor, while two more ships equipped with 3,000-horsepower Doxford engines are to be built. Moreover, the Pacific Steam Navigation Company has just ordered three further 12,000-ton motorships from Harland and Wolff, making six in all, the first of which, the *La Paz,* recently sailed on her maiden voyage to New York, then through the Panama Canal to the west coast of South America. In addition, the Chargeurs Reunis, one of the largest French shipping firms, has ordered a cargo boat of 11,700 tons in which two 1,700 brake horsepower Sulzer engines will be installed.

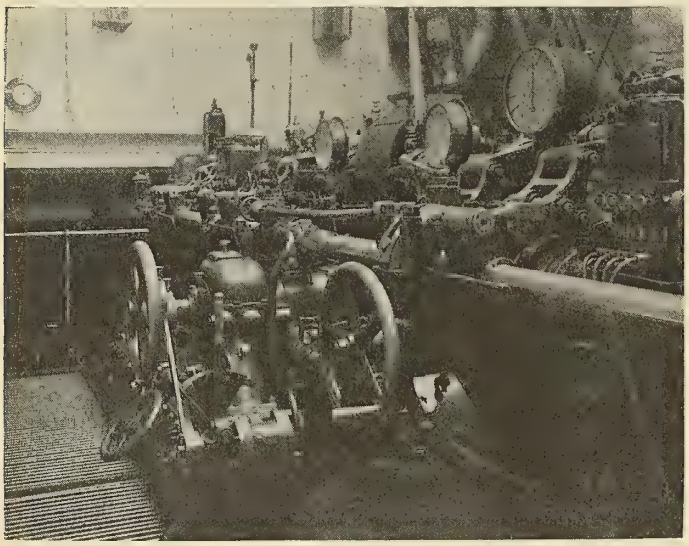


Fig. 2.—Control Station of the 1,200 Horsepower Sulzer Engine in the Converted Ship *Augusta*

Tendency Towards Standardization

The development towards standardization in motorship construction is becoming very marked. The vessel which is now under construction for the Union Steamship Company, of New Zealand, at Denny Brothers' yard on the Clyde, of which illustrations are given, is one of a series of exactly similar vessels, several of which are being built for the British India Steam Navigation Company. In the case of the latter, however, although the hull form remains the same, the accommodation has been provided for passengers, whereas the vessel for the Union Steamship Company has been designed purely as a cargo craft. The length is 450 feet, the beam 58 feet, and the depth 34 feet, the carrying capacity being in the neighborhood of 11,000 tons, a very popular type with British shipowners at the present moment. The machinery comprises two 2,330 indicated horsepower Diesel engines of the new type built by the North British Diesel Engine Works, Ltd., having eight cylinders 26½ inches diameter and 47 inches stroke.

The new vessel is modern in regard to speed, for it is designed to maintain 12½ knots at sea with the engines running at 96 revolutions per minute. Electrical auxiliaries are used throughout, the power being supplied from Diesel driven generators installed in the engine room coupled direct to six cylinder 300 brake horsepower high speed oil engines.

The Motor Tanker Mexico

BY C. E. SPINNLER

WITH the ever-increasing use of oil burning installations on steamships of all classes, as well as the increase of Diesel-driven motorship tonnage, a serious shortage of transportation facilities for the necessary large quantities of fuel oil has been felt during the past few months.

Shipowners and operators are in general dependent on the tank ships controlled by oil-producing companies both here and abroad (about 75 percent of the foreign control is in the hands of British companies). Since the Government tankers and most of the tankers owned by the oil companies are used for supplying the fuel stations throughout the world, private concerns have been more or less depending on deliveries of oil that are made at the discretion of the producers.

To avoid delays in bunkering the ships of its fleet, and to escape having to rely on supplies from fuel stations of the oil companies, the East Asiatic Company, of Copenhagen, which controls a large fleet of motorships, has commenced to build up a tank fleet of its own and provide storage facilities for fuel oil at various ports on its trade routes.

The first of the tank ship fleet, the *Mexico,* was built at the Makskov Yard in Denmark. Before her acceptance by the owners, the ship completed a successful trial trip, after which she left Copenhagen in ballast for New York. Her maiden trip across the Atlantic was very rough, but she arrived in good condition, having been twenty days in crossing.

She went directly to Bayonne to take aboard a full cargo of crude oil, gasoline and a small amount of bulk freight, completing her loading in two days. The vessel then started on her return trip to Copenhagen.

The motorship *Mexico* presents the same general appearance as other vessels of the East Asiatic Company's fleet and is of the general standard Burmeister & Wain type of motorship construction. She is a twin screw vessel with the engine room aft and has the following dimensions:

Length overall	317 feet
Breadth, molded	44 feet
Depth, molded	38 feet
Deadweight cargo carrying capacity	4,700 tons
Indicated horsepower	1,780
Speed of ship, loaded	10 knots

The total bunker capacity of 400 tons gives the vessel a cruising radius of about 67 days, or approximately 16,000 sea miles.

The engine crew of the *Mexico* consists of eleven men, i. e., one chief engineer, three engineers, four assistants and three oilers.

Power is supplied by two six-cylinder Holeby Diesel type engines having cylinder diameters of 19¼ inches, a piston stroke of 29½ inches and a speed of 140 revolutions per minute. The rating for these engines has been given as 800 shaft horsepower per engine, but an analysis of the engine dimensions would seem to indicate that the rated horsepower of 800 shaft horsepower per engine represents the maximum capacity at overload. It can hardly be expected that these engines will run at so high a mean effective pressure as 111 pounds per square inch under service, which pressure would be necessary to obtain the rated horsepower.

Assuming that the Burmeister & Wain standard pressure, i. e., 6.25 atmospheres, or 92 pounds per square inch, is the basis for computing the rating of the installation, each engine turning at a speed of 140 revolutions per minute, the capacity would be 838 indicated horsepower for each engine, or a total of 1,676 indicated horsepower for the vessel, as against the 2,100 indicated horsepower of the builders' rating. With an estimated mechanical efficiency of 76 percent, the shaft horsepower of each engine will actually be 636, or a total of 1,272 shaft horsepower, which will represent quite nearly the correct engine output at sea. The actual fuel consumption of the *Mexico* of 0.314 pound per indicated horsepower per hour and the total fuel consumption of 5.75 tons per 24 hours (as recorded on the maiden voyage), including the Diesel-driven auxiliaries which were running at sea, would indicate that the above calculations were correct. Using these figures as a check, we have the following result:

$$\text{Indicated horsepower} = \frac{\text{Fuel consumption per 24 hours}}{\text{Fuel consumption per indicated horsepower per 24 hours}} = \frac{5.75 \times 2{,}240}{24 \times 0.314} = 1{,}700.$$

This value corresponds with the calculated output using the Burmeister & Wain figures as a basis. The total shaft horsepower with a mechanical efficiency of 76 percent will be:

Shaft horsepower $= 0.76 \times 1{,}700 = 1{,}292$, as against 1,272 shaft horsepower calculated.

From this figure the daily fuel consumption will be 0.415 pound per shaft horsepower per hour, which also agrees very closely with the fuel consumption on other Burmeister & Wain ships, i. e., the *California*, the *Stureholm* and others. As the vessel has fine lines, the loaded speed of 10 knots attained on the trip across was quite reasonable and was, in fact, slightly surpassed on the trials of the vessel in Denmark.

The lubricating oil consumption is about 7.5 gallons per day. The forced feed system is used on the engines.

Construction of the Engines

The main engines, as previously indicated, are of the six cylinder Holeby four-cycle type built by a subsidiary firm of Burmeister & Wain and are to a certain extent copies of the Burmeister & Wain type engines with slight differences in certain of the structural details.

Each cylinder head contains one inlet valve, one exhaust valve, one starting valve, one release valve and one fuel injection valve. The injection valve is a departure from the Burmeister & Wain standard open nozzle type valve and is similar to the needle valve installed on nearly all marine Diesel engines. The valve gear is also slightly different in its minor details from the Burmeister & Wain practice, being more like that used in the McIntosh & Seymour engine. The reverse mechanism is the same as that adopted by Burmeister & Wain.

Each engine has a three-stage air compressor mounted on its forward end driven from the crankshaft. Air at about 1,000 pounds per square inch pressure is supplied by the main compressors for fuel injection. A small bilge pump is driven from the compressor crankshaft extension.

The cylinders, valve heads, compressors, inter-coolers, exhaust manifolds and crosshead guides are cooled with sea water, while the pistons and thrust collars are oil cooled.

As in the other motorships of the East Asiatic Company, all the auxiliaries, both engine room and deck, are electrically driven.

The auxiliary machinery installation consists of:

Two electric generating sets, each made up of one high speed, two cylinder Holeby Diesel engine of 100 brake horsepower, running at 300 revolutions per minute, directly connected to a 70-kilowatt dynamo rated at 230 volts and 300 amperes.

One maneuvering, two stage air compressor directly connected to a 50-horsepower electric motor running at 250 revolutions per minute.

Two centrifugal water circulating pumps for supplying cooling water to the engines, each connected to a 12-horsepower electric motor running at 1,000 revolutions per minute. Incidentally, each pump has sufficient capacity to maintain complete service for both engines in cases of emergency.

Two double-gear pumps for circulating lubricating oil, each connected to a 10-horsepower motor operating at 500 revolutions per minute. These pumps are also of sufficient size to maintain complete engine service.

One general service and ballast pump of the rotary type, driven at 200 revolutions per minute by a 10-horsepower electric motor turning at 750 revolutions per minute, through reduction gearing.

One two-plunger vertical bilge and sanitary pump driven by a 7.5-horsepower motor having a speed of 1,000 revolutions per minute, which operates the pump at 80 revolutions per minute through reduction gearing.

One fuel, air-driven, transfer pump of the duplex type, having a capacity of about 5 tons per hour.

Two electric turning gears each driven by a 5-horsepower motor.

One steam-driven air compressor, about 5 horsepower, for emergency service.

In the engine room aft of the main engines a small workshop, equipped with machine tools, has been installed, so that repairs of a minor nature may be carried on at sea and in port without help from outside. Power is supplied to the tools by a 5-horsepower motor.

The fuel tanks for the daily supply are located on the forward engine room bulkhead and have a capacity of about 2 tons each. At the outboard side of each engine, air storage tanks are provided for starting. A pressure of about 350 pounds per square inch is maintained for this purpose.

Mounted on a gallery over the thrust blocks is a Scotch type two-furnace, oil-fired donkey boiler. This boiler is installed to provide the necessary steam for steaming out and heating the tanks and for operating the steam cargo pumps. All living quarters are steam heated. The boiler is built to carry a pressure of about 100 pounds per square inch.

Steam- and electric-driven cargo pumps are provided and are located in separate compartments.

For ventilating the tanks and for cooling the electric motors, electric-driven blowers are installed in the same compartment as the control apparatus for the cargo pumps. All motors are of spark-proof design and completely inclosed.

The electric-driven cargo pumps of the vertical three-plunger type are connected to 40-horsepower and 60-horsepower motors through reduction gears. Steam pumps having the same capacity are arranged in a separate compartment and are used for pumping light oils and gasoline.

The steering gear is of the Hele-Shaw hydro-electric type and is driven by a 12-horsepower motor operating at 730 revolutions per minute.

All winches, capstans and windlasses are electrically driven and are of the standard design adopted by the East Asiatic Company.

The galley of the *Mexico* has been equipped with electric appliances of various kinds, among other equipment being three boilers heated by a current of 60 amperes; two ranges, one having two holes and the other four holes. The galley was built and installed by the Danish firm Vesta, of Copenhagen.

Piston and Rings for Heavy Oil Engines*

Solid and Forged Pistons Discussed—Method of Forming Piston Rings from Castings—Assembling Forged Pistons

BY W. D. FORBES

SINCE the pressure from combustion in a cylinder is exerted on the moving piston, it is evident that between its sliding circumference and the wall of the cylinder there should be no leak, as otherwise the compression would be reduced and the power lessened. It is evident, therefore, that the most important part of the piston is its rings. We will, however, consider the piston first.

The material for the piston may be a steel casting, cast iron, or a forging.

Two general forms are used; that is, the hollow and the solid types. Designers often state that a hollow piston must be a casting, but this is not correct, for the best design for an oil engine piston is a steel forging. There is no difficulty in making such a piston hollow, for the material allows small cross-sections to be used and greater lightness obtained.

A single piece, or solid piston, should not be considered seriously, for, although it is simple and cheap in first cost, it has the great disadvantage of transmitting the heat of the expanding gases through it far more quickly than if the hollow style is employed, and it does not permit arrangements for cooling. Hollow forged pistons must be made in two or more pieces so that they may be machined.

What is known as "steepling" in a piston is resorted to in order to obtain a long piston rod stuffing box without raising the center of gravity of the engine, which, of course, in marine work should be kept as low as possible. As the top of the piston is steepled, the lower end is recessed to correspond, thus allowing the stuffing box to extend into the cylinder, thus saving height.

In making a cylinder cover, the slight amount of extra metal which is coned up to allow the piston to rise is very small and does not affect the center of gravity enough to count.

Producing Forged Pistons

In making one or two pistons only, the cost is large, as a solid forging or forgings would have to be used. To turn these out takes time. However, if the design is one which has proved efficient, hollow forgings can be made cheaply by the use of dies and the cost of the machine work thereby much reduced.

In a forged hollow piston construction it is only necessary to imagine two cup-shaped forgings placed opening to opening, one recessed into the other and the two pieces held together by the piston rod. If the piston is not steepled, a single forming die will answer for both top and bottom pieces. If the piston is steepled, two sets of dies have to be used for the top and bottom halves. This construction is simple, and the inside of the parts need not be too finely finished in the machining process, although the final cuts should leave the surfaces smooth so that they can be wiped off with waste. The joint may be recessed or made by threading.

The inside of the piston halves must be turned to allow for the recessing of the rings, as it would add greatly to the weight if the sides of the piston were not kept nearly uniform in cross-section. This work takes time, but not much more than is required to machine the surfaces if a casting is used. A casting must also be machined on the inside in order to insure an even section and to make certain there are no flaws of any kind. Many forms of hollow cast pistons cannot be internally machined.

As the ends of the pistons are subjected to the greatest heat, it is well to have the diameters here somewhat smaller than at the middle. The coning of the piston must not, however, be continued to the middle of the piston, but only about an eighth of a diameter at each end, so that a parallel section is found at the middle. It is of great importance to keep the cross-section of the piston even, as in so doing the more even expansion prevents the distortion of the piston and ensures far better working of the engine. The piston, of course, must be somewhat smaller in diameter than the bore of the cylinder and should vary as noted above. Just what reduction should be made must be determined by the material used in the piston and by actual experience. Steel makers state that they can furnish steel which will expand only very slightly, while castings are sometimes very erratic in expanding, no two acting the same.

The fit of the piston should be as tight as possible and still run free; in other words, the piston should just clear the bore under running conditions. This matter of clearance is one which should be determined almost entirely by experiment, but this does not imply that an empirical determination should be resorted to for each piston built. It is inexcusable not to decide the exact clearance for a certain type engine after the first piston is fitted satisfactorily. Once the required clearance for a given size and design cylinder is found, all subsequent engines should be machined accordingly and no further trials need be made to be certain that the pistons fit correctly.

Function of Piston Rings

The fundamental idea of the piston ring is to furnish an elastic medium between the wall of the cylinder and the piston in order to prevent the gases from leaking, thus reducing the compression.

The material for the rings is cast iron and the selection of its quality is difficult, as foundrymen cannot be depended upon to give exactly the same mixture in each heat. It has been my experience that even when exercising every precaution the material in cast iron piston rings will vary quite enough, even when poured at one heat, to give both good and bad results. This variance probably arises from the difference in temperature of the metal when poured and the care taken in cooling the castings. The iron should be soft and fairly close grained, but not too fine—in fact, it is much better to have the iron too open rather than too close.

An empirical rule for determining the width of the ring is to place a decimal point between the figures of the diameter and divide by two. This is true, of course, for cylinders less than, say, 48 inches in diameter. For a 28-inch piston the ring would be 1.4 inches wide. The thickness of the ring should be a little less than half its width. In considering the thickness of the ring we must first determine whether an eccentric or concentric style will be used.

Method of Making Concentric Piston Rings

It has generally been found that concentric rings of diameters up to 48 inches give better results than the eccentric type, so we will only consider the former style.

There are, of course, several methods of making piston

* Second of a series of articles dealing with the design of reciprocating parts for oil engines. The first article appeared in the November issue.

rings, and engineers will do well to follow what has proved satisfactory to them rather than adopt any new method.

The pattern for the concentric type ring is made in the form of a cylinder with a flange at one end. The outside diameter of the pattern must be determined by the amount of spring that the designer considers necessary, and this spring depends as a matter of course on the quality of the cast iron. The casting is chucked with the flanged end out, and the face and edge of this flange are turned up with a smooth cut, the diameter being brought to size by gage. A slight recess is turned in the face plate of the lathe to meet the diameter of the flange. Of course, in first chucking the casting care is taken to insure having it run as true as possible. Into the recess in the face plate the casting is placed and clamped securely. A roughing chip is taken both inside and out and the front edge of the casting is also faced. After this roughing cut is taken, which must be deep enough to get well under the scale, the casting is taken out and another casting machined in a like manner. Of course, if quite a number of castings are being turned out, all the flanged ends are done first to save time. These roughed castings are then allowed to "season"; just how long is debatable, but certainly not less than two weeks.

If time presses and the casting must be used at once, it should be steamed for about ten minutes, more or less, according to the diameter of the ring and the temperature of the steam, allowed to cool and steamed again. At least four steamings should be given it. Time and steam take out the strains set up in the casting, and if they are not relieved the ring will not retain its roundness and will show bright in places after a little running. These hard spots arise from a poor mixture of iron, and the thing most desired in the metal of a piston ring is uniformity in hardness.

The finished size both inside and outside of the ring having been settled upon, the casting is again placed in the lathe, the recess turned in the face plate, allowing it to be set at once accurately. The casting is then bored and turned to size, the front end just skimmed off and a parting tool, or a gang of them, used to part off rings, leaving them wide enough to allow a good finishing cut on both sides.

The parting tool or tools should be ground so that the ring will be cut clean, and this is accomplished by having the ends of the parting tools beveled to the left. Because of this bevel the ring will be parted by the tool point before the left-hand edge of the tool finishes its cut. If several tools are used in a gang, the right-hand tools should lead the work so that the machinist can catch a ring as parted and be ready for the next, otherwise the rings parting all at the same time may be broken, as the machinist cannot catch them all at once.

When the casting is all worked up the rings should be taken to a milling machine and halved down, and this halving must be taken into consideration when determining the outside diameter of the ring, as the lap must be equal to the width of the ring. The inside bore of the ring is completely finished in the boring process and the cut must be fair and smooth. The outside diameter as well as the bore in these operations must be brought to a gage. The joint at the halving down must next be scraped to a nice surface, or, more properly, to two scraped surfaces. In order to do this scraping, a board should be provided on which are stops over which the ring is sprung enough to open the halving so that the inner edges of the laps or tongues can be easily reached. A fine file should be used to turn the inner edges of the laps so that any burr left in milling is removed. The vertical cuts of the halving need not be scraped, as they should always be somewhat open.

The joint having been finished, the ring should next be taken to a lathe fitted with a solid face plate in the face of which is turned a recess a little less deep than is the ring and just right in diameter to allow the split ring to be sprung together so that the halving is not quite closed.

Final Finishing Operations on Piston Rings

A light finishing cut is then taken off the first edge of the ring and it is removed, reversed and the second side finished, bringing the width of the ring to gage. In order to be able to use a gage on the ring, a piece must be cut out of the face plate—in fact, it is better to have two such cut-outs in order to be able to see that the ring has not been "cocked" in reversing it. The ring is now complete except as to its final outside diameter.

This final sizing requires a rig consisting of a solid face plate fitted to a lathe, on which is turned a diameter corresponding to that of the inside of the ring when the halves just miss butting. A flange turned to the diameter of the cylinder bore is left back of this turned diameter. The width of the ring determines the width of the turned part, but it should be just a little less than the ring width. A plate having a bored hole in its center which fits closely over a concentric stud in the center of the face plate is turned up to the diameter of the cylinder bore. A nut and washer are provided for the stud.

If, now, the ring is placed on the face plate and sprung together and the plate brought up against the ring and the nuts tightened, it is evident that the ring will be held securely between it and the face plate. The outside diameter of the ring can now be turned off to the bore of the cylinder and the ring is complete.

A word can be said as to springing the ring together on this fixture for the final turning. If this springing is not done properly the ring will not come out even in thickness. A flexible band, such as a small chain fitted with a roller sheave on one end, will draw the ring together evenly. This is only practical on small rings, but on large ones a steel hoop turned out on the inside and drawn together by means of a screw passing through the two bent out ends of the hoop serves the same purpose.

In order to prevent the ring joints from coming into line, pins are set in them or into the piston to keep the joints staggered. The pins need be but small and they should be set in the piston and holes drilled in the rings to meet them. The pin holes should not go entirely through the rings, as it weakens them. It is a little troublesome, however, to drill the holes and have them register from the inside, though it can be done with a geared breast drill, or if the ring is large a small sensitive drill press can be used. The holding pins should be so placed as to break the joints; their exact position is of no moment. If there are any parts crossed by the ring in its movements, the joints should be so placed as to avoid them, the hole in the ring being directly opposite the joint.

The number of rings described would not answer for very large pistons, but as yet the oil engine has not been made so large in its cylinder diameter as to require any other form.

A piston ring which it was claimed could be used up to 72 inches in diameter and seemed to be practical was shown to me by an Englishman a few years ago. It was made concentric, but having a U-shaped cross-section with the U looking toward the center. Two parallel members stiffened the ring. This stiffness was also increased by the use of a small machine which peaned the surface of the rings between the parallel members. The strokes of this machine could be varied so that the rings were stiffer opposite the joint. A ring so treated should be satisfactory and the peaning machine should be quite as satisfactory on a ring that is not recessed as on one that is.

If the lathe work is done properly, the edge of the rings should only be scraped enough to remove the fine, velvet sur-

(*Concluded on page* 1013.)

Naval Architects Meet in New York

Society of Naval Architects and Marine Engineers Holds Twenty-Eighth General Meeting—Abstracts of Papers and Discussion

THE twenty-eighth general meeting of the Society of Naval Architects and Marine Engineers was opened in the Engineering Societies building, 29 West 39th street, New York City, on Thursday morning, November 11, with Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, in the chair. Rear Admiral Washington L. Capps, U. S. N., president of the society, was absent from the meeting because of official duties which called him to the west coast. The secretary-treasurer's annual report was read by Daniel H. Cox and approved.

Membership in the society has been increased during the past year by 114 members, 65 associate members and 9 juniors. The elections this year brought the membership of the society up to 1,778 as compared with the 1,590 members of last year. The financial report indicates that the balance from the preceding year and receipts for the present year amounted to $34,594.03, while the total expenditures amounted to $20,162.87. The resources of the society at the present time total $54,680.21. This amount, known as the endowment fund, is intended for the development of activities and investigations outside the general work of the society.

The following deaths were reported during the past year: Members, William Boyd, Charles B. Calder, J. Irving Chaffee, Edwin Mills, William T. Nevins, Gustav Prechazka; associate member, Henry L. Gantt.

In concluding his statement in connection with the annual report, the secretary pointed out the necessity of increasing the annual dues of the society to meet the increase in general operating expenses which the society has met with during the past two or three years. During the past year the society has found it necessary to increase the secretarial staff of the organization. Further than this, an extension of the activities of the society by having more frequent meetings, by establishing local sections and affiliations with kindred societies, all of which involve additional expense, have been considered as quite essential to the development of the society, but which are impossible under the present financial status.

Amendments to the constitution covering the new membership and associate membership dues of $15 and junior dues of $10 were passed unanimously.

Election of Officers

The following officers were elected for the terms specified:

Honorary Vice-presidents—W. F. Durand, W. J. Baxter.

Vice-presidents (for term expiring December, 1923)—H. L. Ferguson, F. L. DuBosque, H. A. Magoun, W. A. Dobson.

Members of Council (for term expiring December 31, 1923)—H. C. Sadler, D. H. Cox, C. F. Bailey, W. H. Todd, E. H. Rigg, W. McEntee.

Associate Members of Council—H. L. Aldrich, H. H. Raymond.

Secretary-Treasurer—Daniel H. Cox.

Life Member—Andrew Fletcher.

Review of Conditions in Industry

In his opening address Mr. Ferguson pointed out that "there has been a gradual and sure development of comparatively new ideas in design and shipbuilding during the past year. Oil burning in steam boilers has more and more tended to replace coal as fuel, and on account of the greater convenience and lessened labor has almost become a necessity." Continuing, he said:

"In spite of some setbacks, geared turbines of suitable design are produced by so many that their success is generally accepted. The internal combustion engine is probably receiving more attention at this time than any other one item, and the increasing use and effectiveness of this type of engine may be confidently expected. Electric drive for war vessels has become a demonstrated success in spite of some troubles and is being adapted to merchant ships as well.

"In shipbuilding the growth of the use of oxy-acetylene and of electric welding is one of the most noteworthy developments of recent years, and it would be difficult to estimate the time and money saved by them in quick ship and plant repairs.

"While the outstanding lesson of the great war to our profession was the tremendous economic loss incurred by waiting for the war to build up an American marine, architects and engineers learned other lessons as well. The great value of standardized design, not only of simple cargo vessels but of destroyers, for instance, as well, was clearly demonstrated as never before. Men were trained in remarkably short time to perform all of the simpler operations connected with the building and operation of ships.

"On the whole, the character of work in the new steel vessels has been better than could have been reasonably expected under the conditions. At the present time probably half the men engaged in shipbuilding during the war have been laid off. There will be a further inevitable decrease in shipbuilding due to lack of new orders and the equipment by the Government of practically all Navy Yards to do building, both large and small.

"When prices have fallen sufficiently to attract orders from owners there will probably be a number of new orders, but not enough to keep busy half of the yards in the country. At the present time the Shipping Board has many more vessels of certain types than can be operated successfully. It is believed that the most important thing that can be done at this time for the merchant marine is to have the Shipping Board filled up to full strength so that it can function as originally intended, and make such reports and recommendations to Congress as may in its judgment be necessary to provide and operate a merchant marine. Legislative action may not be entirely agreeable to others well entrenched in the business, but probably no other action with the result of giving us our fair and permanent share in the carriage of our own goods would be much more agreeable. While this society was founded to promote and foster the art of shipbuilding, it must be remembered that there must be something to practice on if the art is to live with us, and I, for one, do not believe we will ever have a merchant marine without some form of protection.

"A cause of congratulation to all Americans interested in shipping has been the growth, particularly during the past year, of the insurance organizations in connection with our business, of a classification society destined to become great, and of American branch banks in many parts of the world. These are all essential and component parts of our commerce and necessary to the proper development of a merchant marine. On the whole, a great work has been done in starting our citizens again upon the sea and interesting many responsible Americans in ships. If the operation of American ships is reasonably profitable, there will be no lack of men or money."

University Education in Ship Construction and Marine Transportation

BY PROFESSOR LAWRENCE B. CHAPMAN

Abstract

As a contribution to America's merchant marine, a course in naval architecture has recently been inaugurated at Lehigh University along lines widely different from other university courses. In the scheme of studies the course follows generally the engineering courses at Lehigh, except that business administration subjects have been made prominent. In introducing these new subjects to the curriculum we have not slighted in the least the basic engineering studies. We have, however, dropped out much of the advanced specialized work often included in courses in naval architecture.

The first year is practically no different from other engineering courses and needs no comment.

In the second year a study of ship construction, consisting of class and drawing room exercises, is begun. This course is given here to familiarize the student with ships and ship construction early in his course and to prepare him for the summer work to follow at the end of the second year. Following the sophomore year the student is required to spend at least eight weeks in a shipyard on hull construction. Lehigh is probably one of the first universities, outside of those giving co-operative courses, that requires this practical summer work as a requirement for the degree. A second summer's work of eight weeks is required following the third year. This summer is, if possible, spent at sea. Special attention is given to electrical engineering on account of the growing importance of electricity on shipboard for propulsion and auxiliaries. The course in naval architecture during the third year is given over mostly to the powering and propulsion of ships. The course in marine engineering is given over mostly to a detailed study of propelling machinery and auxiliaries. During the next few years a large proportion of the time devoted to this course will be given over to Diesel engines.

The study of ship design is begun in the fourth year. Here each student carries through a design for assigned conditions, selecting the proper dimensions, coefficients and displacement for assigned speed and deadweight and works up the lines, estimated weights, etc. A fair amount of attention is devoted to structural details in the senior year, but the main point desired is to have the student grasp the whole problem of ship design. A thorough knowledge of details and methods of construction can only be acquired by actual experience in the shipyard.

Both here and throughout the college course special attention is given to the economic features of ship design and operation. A study is made of operating expenses to emphasize the importance of detention on annual profits. In steam engineering, types of machinery and fuel for the most economical performance of the ship in service are given particular emphasis. The business training given, which is an important element of the Lehigh course, is handled by the College of Business Administration.

Subjects given in the second and third years are preparatory for special courses in marine insurance, foreign exchange and foreign trade given in the fourth year.

The aim of the course, in conclusion, is threefold: First, to turn out men who may in the future become specialists in naval architecture or marine engineering; second, to graduate a type of man who, after devoting several years to engineering work along marine lines, will be prepared, when the opportunity arises, to enter executive positions in the shipbuilding and shipping fields; third, to prepare men to enter the business end of shipping directly upon graduation.

Discussion

This paper having the first place on the list had also the widest and most interesting discussion, it being recognized that the technical colleges of the country are the recruiting field for the profession of naval architecture and that many practical shipbuilders and managers are likely to come from them.

Naturally there were two groups of members who took part in the discussion, those who are in the business of shipbuilding and desire to get well trained men, and the professors who desire to furnish them. Though there was considerable difference of opinion concerning the paper and also concerning the general matter of education, there was a general concurrence of opinion that whatever else the college does or neglects to do, one thing it must do, namely, give a sound, well rounded training in general engineering, together with instruction in the theory of shipbuilding.

Taking conditions as they are with our preparatory schools and high schools, and the fact that the course in a technical college is in practice restricted to four years, the college cannot expect to do much more than this agreed minimum; and that is where the chance for discussion comes, i. e., what else shall be taught in the limited time? Professor Chapman proposes to give considerable time to economics, accounting and business management and an inspection of his paper shows how he accomplishes his purpose. He also claims that his course differs from all others in this regard. The professors from other colleges could not let this pass unchallenged and the discussion was opened by Professor George F. Crouch, of the Webb Institute of Naval Architecture (formerly Webb Academy) who recognized the growing importance of some consideration of management and executive functions in school, but was of the opinion that it is enough to give an introduction so that students shall not fail to know the importance of these matters. As for accounting, he thought the student interested should be able to find instruction elsewhere as many courses are now offered. He also reported the custom at Webb Institute of requiring three full summers of work in shipyards and elsewhere.

Stevenson Taylor, president of Webb Institute, and known to all for his wide and varied experience in practice, explained why the name of the Institute had been changed to avoid misunderstanding and why the Institute does not find it advisable at this time to meet the requirements of the state Board of Regents and does not now grant degrees though the course in naval architecture is considered to be equal to the best. Speaking both as an educator and as a practical naval architect, Mr. Taylor considered that a sound fundamental education is the first essential and that students may be expected to do something themselves for widening their education.

Following a line of thought rather than the order of the discussion, we will give the opinion of Professor Sadler, of the University of Michigan, that there are fashions in education as in other things, and that, while now the fashion is for management, there is a tendency to return to the old fashions. At one time forty alumni were asked to suggest changes in the course in naval architecture, with the result that each proposed some specialty in which he was interested and that ten years would be required to teach them all. Provision for specialties is made by leaving half the senior year for options so that a student may choose management, advanced engineering or what not.

W. T. Bonner stated that the Drexel Institute, which is breaking away from the status of a trade school, now offers a course in naval architecture.

Walter M. MacFarland, who had served as assistant professor at Cornell while attached to the engineers corps of the navy, gave his opinion that four years at a good technical college gave as much education as could be acquired in twenty-five years by oneself.

All these speakers were or had been engaged on the educational side and might have their own bias on that account; the other speakers were free from that influence and their opinions are most interesting. H. F. Norton, of the Newport News Shipbuilding and Dry Dock Company, delighted all the teachers by promising on behalf of his company to give ship drawings freely; when a student he felt the lack of such drawings, then more difficult to obtain. He was of the opinion that the colleges need not worry concerning the production of executives; the yards would develop them. C. F. Bailey, engineering director of the Newport News Shipbuilding and Dry Dock Company, thought it a good idea to let the young men grow up by their own endeavors. Man does not live on his reputation, but by making a reputation.

Launching of Ships in Restricted Waters

BY LIEUTENANT-COMMANDER H. E. SAUNDERS, C.C., U.S.N.

Abstract

At the last meeting of this Society there was presented by the writer a paper dealing with methods employed to check the speed of vessels during launching, with particular reference to a type of friction launching brake developed and used at the Mare Island Navy Yard. A brief description of the launching and checking arrangements for the battleship *California* were given, together with a description of certain model experiments conducted in connection with this work. At the time this paper was submitted, however, the launch of the *California* had not yet taken place and it was proposed to submit a second paper, in the present form, embodying a description of the launch and an analysis of the data obtained at that time.

Before proceeding to a detailed account of the launch, which took place on November 20, 1919, it may be well to note the principal characteristics of this vessel, as bearing upon the data set forth in the following paragraphs:

Length overall	624 feet
Breadth overall	97 feet 5¾ inches
Mean draft at launching	14 feet 9¼ inches
Launching weight complete, with cradle	14,610.5 tons
Pressure on ways, per square foot	2.4 tons
Mean declivity of ways	11/16 inch per foot
Maximum velocity attained	24.7 feet per second
Velocity when brakes were applied	21.5 feet per second

In order to obtain data for a complete analysis of the launching, every effort was made to provide sufficient recording apparatus for all phases of the operation. In addition to the standard drum chronograph previously employed at this yard, a second "direct-reading" chronograph was fitted and both machines connected to the ship by wires which were laid out over the ground ways.

Before proceeding to a description of the behavior of these brakes, it will be of interest to note briefly the organization of the special brake detail and the instructions issued for the guidance of the members of this detail. It has already been stated that there were three full rehearsals of these operations prior to the launch and that all the men were given an opportunity to watch the performance of the launching model, when specially rigged with cables and chains.

The two groups of men operating the hand pumps were directly in charge of a supervisor on each side, who was to superintend the operation and the emergency release of the brakes on that side. It was conceivable that, in the event of a wire cable stranding or kinking, or part of the brake gear carrying away, it might be necessary to release the pressure in one or more sets of cylinders to avoid serious damage.

The brakes were to be set as soon as their respective cables began to pull through (for the brakes Nos. 3, 4 and 5, port and starboard, this would occur at about 568 feet travel). As an additional signal, two large klaxons were to be sounded by the brake control officer at the head of the slip when the ship had run the proper distance and the chain cables had straightened out.

In case the speed of the vessel had not been sufficiently checked at 1,000 feet travel (under normal conditions the vessel should have stopped dead in the water at about 960 feet travel), emergency pressure, 1,150 pounds per square inch, was to be applied, the signal for this pressure to have been five or six short blasts of the klaxons. When the vessel had stopped dead in the water, the brakes were to be quickly released upon signal of the klaxons, to prevent the strain on the cables from drawing the vessel back toward the slip.

The chain cables attaching the friction wires to the ship were flaked down on the floor of the slip so that each chain was clear of the others and separated from its own parts. The tumbling shores, of course, had to remain until the vessel was released, and, although they were directly in the path of the chains, there was no interference and very few of the timbers were thrown about.

From the moment that the vessel was released until she reached 648 feet travel, everything functioned exactly as was planned. At about 560 feet travel the chain cables began to straighten out, and at about 570 feet travel the klaxon signal was given to apply normal pressure on brakes Nos. 3, 4 and 5. Within less than one-half second the operators began pumping on these brakes, and the first application of pressure was sufficient to straighten out the chain cables. The brakes smoked considerably from the start, due to the fact that there was a protective coating on the wire cables of some fish oil preparation, which burned off on the outside of the strands as soon as the cables began to slide. At about 620 feet travel the cables straightened out on No. 1 and No. 2 brakes and normal pressure was applied by the operators.

At 648 feet travel, after the wires on No. 3 port brake had gone about 80 feet through the blocks and a pressure of 500 to 600 pounds per square inch had been applied to the rams, the chain cable on that brake carried away several feet from the pad on the ship's side. The vessel by this time had left the ways and was traveling at a velocity of about 19½ feet per second. At 660 feet travel the chain cable on No. 5 port brake carried away about 420 feet from the ship's side.

One by one, as the pressure on the brakes was increased, their respective cables parted, about half of the chains remaining intact when normal pressure was obtained. At 776 feet travel all chains except No. 1 port had parted; at 780 feet one of the links connecting the outside wire on No. 1 carried away and the inside wire continued to pull through the brake. At 902 feet travel, as soon as this pressure had been applied, this chain cable also parted and the vessel was then running freely with the exception of the pieces of chain dragging along from the pad eyes. The starboard and port anchors were then dropped and the vessel brought to rest as described elsewhere in this report.

Port No. 4 brake was dismantled and opened for inspection immediately after the launching. The wires had traveled about 100 feet through the blocks, but there was no rifling and comparatively little scoring of the grooves. The leading end of the grooves showed practically no wear; the trailing end showed discoloration on the tops and bottoms of the grooves about half an inch wide and 20 to 24 inches long. The concentration of pressure and the resultant generation of heat were almost sufficient to make the metal soft enough to flow. The same condition on the other brakes indicates that the water cooling features of the brake must be improved somewhat and that the cooling must be most efficient where the greatest amount of heat is generated. The operation of all other parts of the brakes left nothing to be desired.

Six of the broken links from the ten chain cables were recovered, and every one showed either faulty weld or very inferior structure. The fact that two of the cables broke before 600 pounds pressure had been applied to the brakes proves that neither excess load nor sudden application of load was responsible for the failure of the chains in this instance. Chain cables for this purpose are considered treacherous and unreliable and far inferior, except for ease in flaking down, to wire ropes with suitable end fastenings. They have not been used in the past at this yard, and they will not again be used in the future. Although in this case the absolute failure of these chains to stand up to their work introduced some unforeseen complications, it is considered that the results, taken all in all, most fully justified the modifications which had been made in the original design of these friction brakes.

Aside from the question of chain cables, the functioning of the hydraulic brakes was, on the whole, so satisfactory that they will be retained in practically their present form for use on the battleship *Montana,* now under construction at the Mare Island Navy Yard. Two additional brakes are to be fitted, making a total of twelve. Although the probable launching weight of the new battleship is almost 50 percent greater than that of the *California,* or about 20,000 tons, the necessary retarding effect is to be obtained by increasing the braking period, making use of the greater part of the channel fairway instead of attempting to stop the vessel in about 350 feet. Wire connecting cables, secured to pad eyes and lashed with small rope stops to the ship's side, will replace the former chain cables laid down on the slip, and the friction cables will be laid out in pipes or boxes instead of being wound on reels.

It must be remembered, however, that the tests were carried out with the limited means then at hand, which permitted only a comparatively short pull on one friction wire at a rate not exceeding about one-half foot per second. It must be remembered also that the tests were conducted with only two cables, which presented clean, bright surfaces to the brake blocks on most of the runs. The friction cables in place at the time of the launch, however, were covered with a partly oxidized coating of heavy oil, just as they had been delivered by the contractor, and the presence of this oil coating may possibly have reduced the friction by an appreciable extent. It appears quite likely, therefore, that at the speeds and temperatures at which these brakes run during a launching operation there is a considerable reduction in the assumed coefficient of friction, although the data given above are unfortunately neither sufficiently accurate nor extensive to fix this value within very close limits.

Discussion

This paper was illustrated by moving pictures of the preparation for launching, of the christening by the fair sponsor, of the motion of the ship down the ways, and of the breaking of the chains which checked the ship, and finally of the ship aground across the channel. Hugo P. Frear, naval architect of the Bethlehem Shipbuilding Corporation, called attention to the fact that the Union Iron Works regularly launches ships across the channel and onto the mud flats. Captain J. H. Linnard, U. S. N., spoke approvingly of the devices described in the paper, especially as the increase in length makes stopping of the ship in a short space increasingly important. On the other hand, William Gatewood, naval architect of the Newport News Shipbuilding and Dry Dock Company, was of the opinion that the declivity was too great and that with just sufficient declivity to insure that the ship would clear the ways ordinary methods of stopping would suffice.

THURSDAY AFTERNOON SESSION

New 20,000-Ton Tankers

BY HAROLD F. NORTON

(This paper is published on page 970.)

Discussion

The interest of this paper is largely in the presentation of methods of meeting difficulties of construction in new tankers of great size, this one having a displacement of 20,000 tons, and being alleged to be the largest yet built, and having the largest Scotch boilers. Both these claims were questioned by Hugo P. Frear, who humorously claimed that his company had built ships that could be called 40,000-ton ships; these were designed to carry oil to Chili and bring back ore, being specially constructed for that purpose. As shown by the author, the pump room is the same size as an oil tank, giving simplicity of construction and also, as Mr. Frear pointed out, improving the distribution of weights which in this type of ship is likely to be concentrated amidships; there have been certain casualties due to such overconcentration. D. H. Cox raised the question whether there was any real economy in the use of a straight sheer, especially as it affects the allowed freeboard.

In the author's reply the most important item was the explanation that the provision of voids amidships to improve the weight distribution, though well understood by naval architects, is difficult of accomplishment because the owners are influenced by their captains, and the captains are unaccustomed to voids in that locality; voids near the ends are more familiar to them.

Economical Cargo Ships

BY ALFRED J. C. ROBERTSON

This paper is a continuation of the valuable investigations which were reported by the author at the 1919 meeting of the Society. The extensive study of full form cargo vessel models at the experimental basins in Washington and at the University of Michigan indicates the direction in which designs may best be developed in the future. The complete paper is published on page 990 of this issue.

Discussion

As explained in the paper, the information concerning resistance is extended into a field not covered by previous investigations at experimental basins, which have been largely employed on naval and fast passenger steamers. Professor H. C. Sadler, who is in charge of the experimental basin at the University of Michigan, where these investigations were made for the Shipping Board, was able to give valuable supplementary information. The society was pleased to learn that another series of experiments is under way, which, like the present series, will be available for the profession. The various series on full bodied models brought out some unexpected results; for example, in at least one case a smaller prismatic coefficient was accompanied by greater resistance, which is contrary to the usual idea.

Professor Sadler explained also that discrepancies between results from different experimental basins were usually due to differences in conditions. At one time he towed a model of a submarine at Ann Arbor after it had been towed at Washington, taking care to have the conditions identical; in this case the comparison of results was satisfactory. E. H. Riggs, naval architect of the New York Shipbuilding Corporation, confirmed the fact that fuller bodies did not always mean harder driving; in a specific instance the removal of 200 tons from the bow of a ship to get finer lines did not improve the resistance. He referred to the inconvenience that arises from the fact that results from various basins are expressed in different forms, each of which had to be learned and could not always be reconciled; the present paper aids in overcoming this difficulty. Professor E. M. Bragg, of the University of Michigan, conveniently summed up the situation, as it now appears, by saying that for a full bodied ship having a speed ratio of 0.5 to 0.6 the distribution of displacement should be 28 percent for the entrance and 42 percent for the run. There is also the apparent anomaly that at very low speed the entrance should be longer in proportion to the run; at higher speed the entrance may be decreased, but with continued increase in speed the entrance must again be increased. The penalty of making entrance and run of equal length, as is commonly done, can be given as 10 percent increase in power.

Notes on Rivets and Spacing of Rivets for Oiltight Work

BY HUGO P. FREAR

Abstract

The present high state of efficiency of the modern tanker leaves little to be said on rivets and rivet spacing for oiltight work that would be both new and conservative, and it may safely be said that radical departures from the practice arrived at as the result of years of experience would invite trouble. Riveting is unquestionably one of the greatest, if not the greatest, item of expense entering into the cost of construction, and the unprecedented demand for tankers and oil burning vessels at this time magnifies its importance.

Rivets and spacing of rivets for oiltight work, as covered by the classification rules, Navy Department, British Admiralty, etc., do not vary radically, although, on account of higher stresses used, a greater spacing is adopted in some parts for naval vessels. It must be borne in mind, however, that naval vessels are not subject to the great variations in load encountered in the merchant marine, and therefore the stresses can be anticipated with greater accuracy.

Rules for rivets and rivet spacing are the result of evolution arrived at by rule of thumb, experience, size of rivet found practicable to drive, spacing suitable for calking, experiments, calculations, survey reports on damage cases, etc., and are in the opinion of the writer generally satisfactory.

Oil tightness depends, perhaps, more on good workmanship than any other one thing, especially so far as riveting is concerned. If every rivet could be guaranteed 100 percent perfect, slightly greater spacing would be practicable and might be allowed by classification societies except where a given efficiency of joint is essential.

While there were probably some barges in existence prior to 1872, it was in that year that the first bulk oil carrying steamer was built at Palmer's, Newcastle-on-Tyne, England. Although this vessel was built especially for carrying oil in bulk, she had a double bottom, and the indications are that the rivet spacing was the same as in vogue at that time for watertight work.

During this period the spacing of rivets, even for watertight work, was in some respects greater than at present and vessels frequently leaked a little when new, but they were built of iron and the joints soon rusted up tight, thereby increasing the friction of the riveted joints and resulting in stronger and more durable vessels under existing conditions. This rusting-up process, however, would not take place in the case of new vessels built to carry crude or lubricating oils in bulk, and on that account some of the converted vessels were tighter than new tankers.

Oxidation, however, takes place in tanks carrying gasoline, and this rusting up process, undoubtedly, penetrates into the seams. On this account it might be beneficial to carry a cargo of this character on the first voyage or two as is sometimes done.

Up to 1894 there were built or building to Lloyd's Class sixty-four tankers, yet the Society did not consider that it had sufficient experience to lay down definite rules for their construction. In this year, however, Benjamin Martell, chief surveyor to Lloyd's Register, read a paper before the Institution of Naval Architects wherein he outlined his views on the details of construction and of riveting for bulk oil carriers, recommending three diameters for oiltight work. Within a comparatively short time after this, Bureau Veritas, apparently profiting by this paper, published rules for tankers, and the American Bureau of Shipping published their first rules in 1902, but the first rules of Lloyd's did not appear for general use until 1909. Both Bureau Veritas and the American Bureau recommended three and one-half diameters at the start, while Lloyd's specified one more rivet in a frame space than required for watertight spacing resulting approximately in three and one-half diameters.

Evolution was a slow process, and no doubt in numerous cases the true cause for failure was not recognized. Mr. Martell realized this when he wrote his paper and provided for tanks not over 24 feet in length increased stiffeners and brackets, as well as closer spacing of rivets. Had the earlier tankers been better designed as regards tanks, stiffeners, brackets and compensation, where needed, the question of rivets and spacing of rivets for oiltight work might possibly have received somewhat less attention during those troublous times. This appears to be a reasonable inference from the fact that so many converted tankers have since given long and satisfactory service.

That oiltight work should be double riveted was an accepted rule. This is still the general requirement, but single riveting is now permitted in the seams of double bottoms intended for carrying fuel oil. Lloyd's formerly recommended single double riveted bulkhead bounding bars but later gave the builder the option of using double single riveted bars. The general practice now is to use double single riveted bars with countersunk heads and points and bars calked on both flanges on each side. The writer is inclined to favor single double riveted bounding bars and pan head rivets in standing flange with calking on one side because it is believed this lends itself to cheaper and better workmanship and would insure the parts being drawn up more closely. Countersunk heads are, of course, unavoidable in the shell flange. Where double bounding bars are fitted, careful workmanship is necessary to insure the two shell flanges lining up perfectly for intimate contact. Conditions, however, would be substantially the same as with single bounding angles. Pan head rivets could be used except in one flange, three ply work would be eliminated, and only two edges would require calking. A single angle as recommended above would have the same number of rivets, the same amount of calking, and be more easily set.

In gunwale bars, Lloyd's require four and one-half diameters for watertight work and five diameters for oiltight work, which does not seem consistent. In a recent case, 1-inch rivets were spaced five diameters in a 5-inch by 5-inch gunwale bar for oiltight work and appeared to be too crowded for the width of flange and size of rivets.

The extensive use of oil for fuel in naval vessels during the last few years has brought up for consideration and settlement many problems in design which did not exist in coal burning vessels. In vessels of great length such as scout cruisers and battle cruisers, longitudinal bulkheads are used as strength members. The riveting connections in these bulkheads must be designed to obtain maximum strength, and therefore the riveting should not be so closely spaced that more material is punched out of the plating than allowed in the calculations, without compensation. If, however, these bulkheads form boundaries of oil tanks, it becomes a matter of importance, when transverse bulkheads join the longitudinal strength bulkheads, to avoid too close spacing in the bounding bars. If the strength bulkhead is designed for a spacing of six diameters for rivets in stiffeners and oil tightness demands five diameters at a transverse bulkhead, it becomes necessary to introduce compensating liners which add to the weight and, on account of the extra thickness of plating, increase the difficulty of making the structure tight.

The hull division of the Philadelphia Navy Yard recently made a test on an experimental box to determine if a six diameter spacing of rivets would be satisfactory under the conditions as stated above. Six diameters might be quite suitable on a deck near the neutral axis but unsuitable for parts subject to stresses resulting from the vessel working in a seaway or from shocks of gun fire or explosion. In this test it was found that the calking of bounding bars to heavy bulkheads was satisfactory under a 60-foot head with a six diameter spacing in the connection of transverse to longitudinal bulkhead and five diameter spacing in bar connecting to the shell.

A similar tank was also recently tested at the New York Navy Yard to demonstrate the efficiency of six diameter spacing for T-bar stiffeners and for bounding bars to bulkheads. The tank was first subjected to a test head of 65 feet of water and found to be tight; then to a twenty-four hour endurance test with oil at the same pressure. Then the pressure head was increased to 93 feet, which pressure was maintained for four hours without leaks.

One of the larger builders, as a result of mathematical analysis, has suggested the following spacing as permissible, provided that considerations other than oil tightness did not determine the spacing:

TABLE I.—PROPOSED SPACING OF RIVETS

Diameter of Rivet, Inches	Thickness of Plating, Inches	Spacing in Diameters
¾	5/16	3.6
¾	⅜	4.2
⅞	½	4.9
1	¾	5.6
1⅛	1	6.3
1¼	1¼	7.0

The above spacings were based on the supposition that 3½ diameters were satisfactory for a 10-pound plate using ⅝-inch rivets, and assuming that the deflection of the plate edge caused by calking probably varies as the ratio of the fourth power of the distance between rivets to the fourth power of the thickness of the plating, and that the extension of the rivet varies as the ratio of the distance between rivets to the area of the rivet.

A naval constructor stationed at the same yard carried the investigation further by considering the deflection that is caused by calking and by the amount of general deflection of plating due to water pressure, and suggested that based on the assumptions made the following spacing would be satisfactory: 15-pound plate, 4 diameters; 20-pound plate, 4.5 diameters; 25-pound plate, 5 diameters; 30-pound plate, 5.3 diameters; 35-pound plate, 5.6 diameters.

The analysis used in deriving the above tables of rivet spacing for oiltight work was made to confirm a theory that every unnecessary rivet is a possible source of leakage, and that for heavy plating a wider spacing would be permissible but considered only the stresses on the plating and rivets due to calking to the exclusion of the more complex stresses experienced under service conditions. If the spacing suggested in the above tables is suitable for oiltight work, it might be necessary to increase the number of rows to insure proper strength and friction of the joint, in which event there would be an increase in weight and the attempt to reduce the number of rivets defeated.

DISCUSSION

The discussion of this paper, like the paper itself, presented a mass of important information concerning allowable practice in riveting for oiltight work. Much of the discussion was written and, again, like the paper, it was difficult fully to appreciate the numerous details disassociated from concrete examples. The paper and the discussion will be a mine of information to those who need it and who will be ready to take the trouble to consult the transactions of the society for that purpose.

FRIDAY MORNING SESSION

Comparative Tests of Bilge Keels and a Gyro Stabilizer

BY COMMANDER WILLIAM MC ENTEE, C.C., U.S.N.

ABSTRACT

In recent rolling experiments carried out at the United States experimental model basin on a model of the *Langley*, the results obtained are believed to be of sufficient interest to naval architects to warrant making them the subject of a paper for this Society. Incidentally there is shown one of the purposes for which the wave-making equipment at the model basin is employed.

The experiments had for their object a comparison of the quenching powers of bilge keels and of a gyro stabilizer so far as may be determined by model tests. As the *Langley* is being refitted to carry aeroplanes which are both to fly from and to land on her deck, it appears that the prevention of excessive rolling is a matter of greater importance than for other vessels.

For use in the tests a small gyro stabilizer was obtained from the Sperry Gyroscope Company. This was an exhibition stabilizer, and as it was not designed especially to suit the model it was larger than necessary. Also the speed of the precession motor was not well adapted to the period of the model to give most efficient results. The designed stabilizing moment of the twin gyros when running at 7,000 revolutions per minute is 57.4 pound feet, but during the tests the speed was cut down as far as possible to about 2,300 revolutions per minute, reducing the stabilizing moment to about 20 pound feet.

The dimensions of the *Langley* are: Length, 520 feet; beam, 65 feet; draft, 16 feet, and 11,000 tons displacement. The model to 1/26th scale was first fitted with bilge keels, representing to scale, keels 15 inches deep by 180 feet in length and rolled in still water to obtain its declining angle curve. The bilge keels were then removed and another declining angle curve obtained. Without bilge keels to reduce the angle of heel from 11 degrees to 3 degrees required about 54 swings as compared with 8 swings with bilge keels.

The model was next rolled with and without bilge keels and with the gyro stabilizer in waves. For this purpose it was held broadside to the waves by single head and stern lines made fast to the model at the waterline close to the longitudinal rolling axis. The height and period of the waves could be controlled within limits and could be so adjusted as to produce marked rolling. In the same system of waves the bilge keels reduce the arc of roll from 26.4 degrees to 9.6 degrees, or about two-thirds, while the gyro stabilizer reduced it very quickly when cut in, from 34 degrees to 3 degrees or to about one-eleventh of the uncontrolled roll.

The model was then tested in waves approaching half the period of the model. With the bilge keels in place, when the wave length was shortened so that the rolling was no longer synchronous the model stopped rolling almost entirely, and no other wave period could be found that would induce rolling to any extent. When the bilge keels were removed, however, it was easy to find a period of wave in the vicinity of the half period of the model that would cause very heavy rolling. The angle rolled through was so great that it was necessary to use a shorter arm for the pencil of the gyroscopic roll recorder, thus changing the scale for angle of roll on the records and running up to at least 48 degrees. When cut in, the stabilizer almost instantly cut down the maximum roll to about 2 degrees.

As it was apparent from the preceding tests that the roll quenching capacity of the gyro stabilizer was more than ample for the model, an investigation was next made to determine its performance, without bilge keels, in higher waves, the higher waves being obtained by increasing the eccentricity of the wave maker while attempting to keep the period of the wave such as to produce maximum rolling.

The estimated stabilizing moment of the gyro stabilizer as run during the experiments was 20 pound feet. This was the minimum stabilizing moment which could be obtained because the gyro motors could not be run at any lower speed. To compare the estimated stabilizing moment with a known impressed moment, additional tests were made in which the stabilizer was operated against a rolling moment produced by a weight moving harmonically from side to side in the model through a distance of 8 inches. By controlling the speed of the motor it was possible to make the harmonic rolling moment agree with the natural period of the model. By varying the weight it was possible to increase or decrease the rolling moment. With a maximum rolling moment of 31.33 pound feet, the gyro stabilizer reduced the roll from 37.5 degrees to 3 degrees.

It is to be noted, also, that it required several rolls before the angle was so reduced. When the rolling moment was increased to 39.33 pound feet the roll was reduced by the gyro stabilizer from 46 degrees to 5 degrees, though taking a somewhat greater number of rolls to do so. When still further increase in the rolling moment was made to 47.33 pound feet the capacity of the gyro stabilizer was clearly insufficient to cope with the same, the roll being reduced from 42 degrees to 34 degrees only.

As a final test an investigation was made of the increase of towing resistance of the model when caused to roll by an harmonic rolling moment applied to the model while being towed in smooth water. The results obtained were reduced to effective horsepower curves for the ship. From these it appears that at a speed of 15 knots the effective horsepower would be increased from 3,000 to 3,300 when the ship is rolling through an arc of 25 degrees, and to 3,600 when rolling through an arc of 45 degrees, corresponding to an increase in effective horsepower of 10 percent and 20 percent respectively. It is to be noted that this does not include the loss of power due to decrease in propeller efficiency for a twin screw ship, when the propellers alternately approach the surface, if not actually coming out of the water.

These results confirm experience at sea that loss of speed is found to occur when ships are rolling heavily. Under these circumstances it appears that the power and weight devoted to the means for stabilizing a ship are more than amply repaid by the saving effected in the power required to drive her.

Discussion

This is the first article published since a wave-making apparatus was established at the Washington experimental basin and is therefore most interesting and important. The author pointed out that 20 foot pounds of stabilizing moment by the gyroscope were able to cope with a wave which had a maximum of 36 foot pounds of rolling moment.

Taking up first certain questions and answers together, which of course were separated in the discussion, the author explained that experiments on towing models among waves did not yield information concerning the influence of yawing on resistance, nor the difference between single and twin screws. It is expected that trials in prospect on the *Anderson* with and without stabilizers will answer these questions. The author further agreed with Professor Sadler that the effect of rolling at sea, as shown by a year's work compared with model experiments, was a loss of 10 percent in speed; in other words, this can be expressed as a demand for 30 percent more power for the same speed. Homer Ferguson, president of the Newport News Shipbuilding and Dry Dock Company, said that the trial speed was usually made to show a knot more than was expected in service.

Elmer Sperry, president of the Sperry Gyroscope Company, added to the interest by giving supplementary information. In the first place he said that his provisional computation of losses in speed due to rolling were so large that he cut them down to a fraction before reporting them, but that these experiments show his estimates to be fairly correct. He emphasized the fact pointed out by the author that the model in the basin could not yaw and had no helm, and so no report could be made on such influence on resistance. A very important matter is shown by these experiments on rolling, i. e., that a stabilized ship does not ship seas; this was predicted by Sir William White many years ago. Mr. Sperry further emphasized the rapid action of the stabilizer as compared with bilge keels; he pointed out that, like the poor, the ship always has its bilge keels with it, while a stabilizer need work only when required.

Surface Condensers

BY LUTHER D. LOVEKIN

Abstract

In the earlier days, when the old reciprocating engine held full sway, it was useless to consider high vacuums, as there was no economy to be had by the use of a high vacuum on account of the large volumes of steam to be cared for. In other words, any vacuum above 25 inches really proved to be a loss rather than a gain as one might expect, due to the design of the ordinary reciprocating engine.

The stationary engineers of the world, with the wonderful research laboratories at their command and the further advantages in being able to make exhaustive tests on actual installations, undoubtedly led the way for improving vacuum and also for taking care of other losses incident to high vacuum, and the marine engineer has been, and should be, content to profit by their experience in developing means for insuring high vacuum under decidedly different conditions.

Items that the marine engineer has to consider seriously are weight and space, so that what might be good engineering for stationary practice in condenser design would be impossible for marine practice. I refer more particularly to tubes above ⅞ inch in diameter being used; in fact, all condenser tubes for marine work are practically confined to two sizes, namely, ⅝ inch and ¾ inch outside diameter.

Apart from the design of condensers for steam turbines, marine engineers have shown little interest in designs for surface condensers, and even at the present time we find many engineers specifying condensers having so many square feet of surface per horsepower and a certain size of tube, with no regard whatever for the principal features of condenser design, such as velocity of water and the tube length necessary for extracting the British thermal units in the steam. Some figures and designs are here given which are the result of much thought on the problem of surface condensers.

During the years of 1907 to 1910 the author made some very interesting and instructive tests in heat transmission for various purposes. These were followed by numerous tests on the same apparatus by the Engineering Experiment Station at Annapolis, Md. In 1915 he made a series of tests on single tubes, ⅝-inch outside diameter, placed inside of tubes of varying diameters. With a ⅝-inch tube, about 4 feet long, placed inside of a tube about 1½-inch inside diameter, a temperature rise of 60 degrees F. was obtained. By placing this same ⅝-inch tube inside a tube 2-inch inside diameter, a temperature rise of 100 degrees F. was obtained with the same steam pressure and the same conditions of test. This showed conclusively that the steam space surrounding the ⅝-inch outside diameter tube was a most important factor.

The author then ran a series of tests with varying velocities of water and obtained a heat transfer of about 2,750. An apparatus was then built having about one hundred tubes, ⅝-inch outside diameter, with the conventional tube layout, and this apparatus was tested exhaustively by the engineers at the Annapolis station in both vertical and horizontal positions, these results showing a heat transfer of about 1,000. This clearly proved the advantage of having ample steam space between the tubes, so it was decided to design a surface condenser with tubes spaced well apart at the entering rows and to gradually decrease this spacing to normal at the point where the condensate left the tubes.

The experiments on the various appliances showed that it was a serious mistake to fill up an enclosure with as many tubes as it could hold. Why not endeavor to produce a design whereby a maximum inlet area between the tubes could be obtained, so that with a volume of steam corresponding to a vacuum of 28½ inches we would have a velocity of about 100 feet per second or less? Instead of the method of permitting this steam to travel through a bank of tubes after it had already been condensed and allowing the cold circulating water to cool the condensate, it was decided to reduce the depth of the bank of tubes to about half of that ordinarily used and to permit the condensate to be drained from the bank of tubes at its maximum temperature, "which should be approximately that of the temperature corresponding to the temperature of the vacuum."

Realizing the great value of reducing the volume of air and non-condensable vapors, a liberal cooling chamber was provided of efficient form. When used for battleships or the like this air cooling space was enlarged, thereby providing about 40 percent of the total tube surface. This enabled the outer portion of the condenser to serve as a primary condenser and the so-called air cooling space a secondary condenser.

Thus, when the turbines are operating at less than full load the primary condenser can do all the work and retain its heat in the condensate instead of falling over a bank of tubes equal to about one-half the diameter or depth of the condenser, for no other purpose than to reach the bottom of the condenser so it can be drained off by the pump. Draining the condensate off in stages after it has been condensed appeared to be more rational, and the test data confirm this belief.

It has long been known that infiltration of air through cast iron condenser shells is the source of great trouble and annoyance with high vacuums. In order to reduce this to a minimum we made tests without any coating on the shell, then with one coat of bitumastic enamel, and finally with two coats of enamel. The effect of the final coat was an improvement of nearly 1 inch of vacuum under the same conditions.

Particular attention is called to the air channel way in these condensers, it being formed of two plates running the entire length of the space between the tube sheets, these plates being spaced apart and having their sides perforated with small holes over the entire plate. This is done so as to prevent any air pockets being formed in any part of the condenser. Where the condensate pump and air ejectors are used, such as on the proposed surface condenser for United States battle cruisers, it will be noted that the condenser head is cut away so as to clear the air ejector connection. This makes a very simple connection and yet prevents the air pipe being flooded with water. In order to ascertain the height of the water in the condenser shell, a water gage glass can be connected between the condensate suction pipe and the shell, which will readily show the height of the condensate, if any, within the condenser shell.

It is almost unnecessary to state that the design of a surface condenser for battleships and the like which are subjected to their maximum speeds for comparatively short intervals of time is an entirely different proposition from that of the merchant ships, where the maximum speed is run the greater part of the time. In a case of the battleships we can afford to force a greater amount of water through the tubes than we can in the case of a merchant ship, for the reason that the cost of pumping the water for the short time that these vessels run under their maximum conditions is more than offset by the reduced size, weight and space which can be obtained by using more water.

In conclusion, I wish to emphasize the fact that had the marine engineers of the world fully understood the principles of surface condenser design during the past twenty-five years as well as they do today the surface condensers for most of our reciprocating engines in the merchant service could have been built with from 25 to 50 percent less surface and still had the same reserve factor for dirty tube surface. This would have been a valuable conservation of both our physical as well as our natural resources.

DISCUSSION

The discussion brought what is evident from inspection of the paper that the tests on the condenser in service, which perhaps are the most important item in the paper, suffer as service tests commonly do when compared with laboratory tests in that it is difficult, if not impossible, to get ideal conditions; such tests, with due allowance for conditions, are nevertheless valuable. Further, it was brought out that ideal conditions for large heat transfer coefficients may not be profitable in that the cost of pumping to force a high water velocity in the tubes may more than offset the gain in thermal efficiency. One point, well known but frequently forgotten, is that the auxiliaries exhausting into the condenser deliver an appreciable amount of oil which fouls the tubes. (Query: Why not use electric auxiliaries and cut out this trouble?) The author, in reply to the criticism that he used well-known devices in designing his condenser, claimed properly that a competent assembly of such devices to make a good condenser had the elements of originality.

FRIDAY AFTERNOON SESSION

Rules and Regulations for Freeboard

BY DAVID ARNOTT

(This paper will be published in an early issue.)

DISCUSSION

This paper, which presents in convenient form the present condition of freeboard for seagoing vessels, did not call for much comment. The general opinion was that, while vessels navigating inland waters and coasting vessels should receive special consideration, there is little likelihood that either class would be much inconvenienced even though they were subjected to the rules for seagoing vessels, since the conditions of service ensure good freeboard. It was also generally regretted that the question of strength should be injected into governmental rules for freeboard; it was thought that the matter of strength might be left to registration societies.

Recent Advance in Oil Burning

BY ERNEST H. PEABODY

ABSTRACT

The United States Navy is again pointing the way to future development in oil burning. In co-operation with leading mercantile interests who are manufacturing equipment for the Navy, they are experimenting not only in the use of heavy viscous oil but are demanding larger units and greater individual capacity both in boilers and in oil burners. I predict that this increase in size and rate of forcing will mark the trend of future development in the merchant marine.

I am indebted to the American Bureau of Shipping for permission to use the following estimate of the number of oil burning vessels as compared to those burning coal:

TABLE I.—ESTIMATED FUEL ARRANGEMENTS OF AMERICAN OWNED VESSELS

	Vessels	Percent
Coal burners, approximately	993	37.8
Oil burners, approximately	1,260	48
Balance (mainly non-propelled)	369	14.2
American vessels	2,622	

Thus, while very large vessels are using oil fuel successfully and from the estimate of the American Bureau of Shipping it is evident that nearly 56 percent of the present American self-propelled merchant fleet consists of oil burning vessels, it is probable that in not one of these ships is there a boiler containing more than 4,500 square feet of heating surface in the individual unit and no single oil burner capable of atomizing over 600 pounds of oil per hour, while the oil burned per hour per square foot of heating surface under forced draft conditions will not equal one-half pound.

In other words, the present boiler and oil burner practice in the merchant marine is following closely along the very conservative lines of previous custom, and the full value of the use of oil fuel has not yet been approached.

The remarkable economy of the properly designed small tube express type watertube boiler at high rates of forcing with oil fires was demonstrated not very long ago in some notable tests at the Fuel Oil Testing Plant. The tests were conducted under the direction of Lieutenant-Commanders A. M. Penn and W. R. Purnell, United States Navy, and their staff of trained assistants. The boiler was of the White-Forster design, built by The Babcock and Wilcox Company, and contained 7,565 square feet of heating surface and 753 square feet of superheating surface, the furnace volume being 751 cubic feet. Three different types of air registers were used: The Bureau of Engineering forced draft design (of which there were sixteen units installed), the Bureau of Engineering natural forced draft design (eleven units), and what was then known as the Peabody register manufactured by The Babcock & Wilcox Company, designed for either forced or natural draft and of which there were also eleven units.

It will be noted that in the highest capacity test of June 10, 1919, there were eleven burners in operation, each atomizing 1,032 pounds of Navy standard oil (25.5 Baumé) per hour, giving a consumption of 1.5 pounds of oil per square foot of heating surface per hour. The evaporation of water per pound of oil from and at 212 degrees F. was 15.14 pounds, giving an evaporation of water per square foot of heating surface per hour of 22.73 pounds from and at 212 degrees with an efficiency of 76.15 percent. The air pressure in the closed fireroom was 9.5 inches and the rate of combustion per cubic foot of furnace volume reached the very high figure of 15.12 pounds of oil per hour. It is believed that this test stands as a world's record for efficiency at high boiler and furnace capacity.

Early in the past summer The Babcock and Wilcox Company offered six air registers of their standard design, but of an enlarged type, with mechanical atomizers capable of atomizing 1,500 pounds of oil per unit per hour. These were tested by Commander Purnell under the same White-Forster boiler already described. The six burners successfully sprayed over 9,000 pounds of oil per hour under conditions similar to those pertaining to the United States scout cruisers now under construction. The oil per square foot of heating surface was approximately 1.2 pounds, and the oil per cubic foot of furnace volume per hour about 12 pounds.

This record was exceeded in August in a test of the Normand boiler at the Fuel Oil Testing Plant. This boiler contained 4,500 square feet of heating surface and 487 cubic feet furnace volume and was fitted with three of the recently developed Peabody-Fisher wide range mechanical burners and new Peabody air registers. Crude Mexican oil of 13.3 Baumé was used and the three burners each atomized over 1,800 pounds of oil per burner per hour, without smoke, carbon or other objectionable conditions. The oil burned per square foot of heating surface was 1.2 pounds per hour and per cubic foot of furnace volume 11.15 pounds per hour.

A new record in oil per burner per hour was established on September 17 by Commander Purnell when three of the six Babcock and Wilcox units were tested, the burners being supplied with larger tips. The oil used was 19.9 Baumé. The test was of one hour duration but followed several hours' steaming, during which the individual burner capacity was pushed up to 2,000 pounds per hour. The record for the hour shows 2,238 pounds, while in the last half hour the rate of combustion per burner reached 2,287, a safe margin over one ton of oil per burner per hour.

It is worthy of note that six months ago fifteen burners were being considered for each of the sixteen boilers of the battle cruisers now being laid down. On the basis of this last performance only five would be required, and seven would be a safe estimate. To develop 180,000 horsepower with 80 or even 112 oil burners is a very notable performance, but there can be no doubt about its being entirely possible with the equipment which has been perfected in this country.

I do not wish to be understood as saying that I think that oil burners atomizing a ton of oil per burner per hour will be immediately adopted for naval service, far less for the merchant marine, but the trend of modern development is certainly in the direction of larger units and the higher capacities made possible by the use of oil fuel.

Referring to the matter of flexibility, I think I am justified in discussing another recent development which I believe marks a distinct advance in the oil burning art. It is well known that the mechanical atomizer of the usual design has a decided limitation in range. Unlike the steam atomizer, it cannot be operated at low capacity if it is designed for a high one. The lower limit with the oil pressures ordinarily used is approximately one-half the upper.

In atomizers of the Thornycroft type, in which the size of the tangential channels may be reduced by an adjustment in the burner, the velocity through the channels is kept up to a large extent at low powers, and the range of these burners is much greater than in those of the usual type. But it has been found difficult in practice to make individual burner adjustment under service conditions, and this method has never become popular.

Another and radically new plan, however, has been devised which promises very satisfactory results. This consists of maintaining the whirling motion in the central chamber of the tip undiminished whatever may be the capacity desired of the burner; in other words, instead of delivering through the orifice all the oil which enters the burner chamber, as is invariably done in all other mechanical atomizers, a part of the oil supply is diverted or by-passed from the central chamber and returned to the pump suction, and the actual effective capacity or amount of oil which is sprayed into the furnace depends merely on the proportion of the oil that is by-passed to the total amount entering the burner. Thus, as the amount of oil entering the central chamber through the tangential slots remains at all times at the maximum, the whirling of the oil and the atomizing effect remains also at a maximum, so that a perfect spray is secured whatever the capacity, at low powers as well as at the highest rate. By this method the range of the atomizer is very greatly increased, and instead of being limited at the low powers to 50 percent of the maximum a good spray can be secured all the way down to about 10 percent of the total. This method of spraying is the invention of Commander J. O. Fisher, United States Navy, now fleet engineer of the United States Atlantic fleet. It is believed that the wide range in capacity will make the burner especially useful for fluctuating loads or in any installation where it is now necessary to change the tips or close off a portion of the burners.

It may be of interest to state that the burners having a maximum hourly output of 1,820 pounds which were tested at the Fuel Oil Testing Plant were successfully operated at 250 pounds, while smaller tips designed for a maximum of 800 pounds were operated at a minimum of 80 pounds per hour.

A matter closely allied to the use of oil as fuel, in which there has been no advance, and, if anything, a retrograde movement, is the measurement of the viscosity of oil.

It is probable that if the Saybolt viscometer had been obtainable by anybody outside the large oil companies ten or twelve years ago when the mechanical atomizer began to be used extensively, we should not now be using the Engler instrument at all in this country, notwithstanding its extensive use in Europe. But some method of determining viscosity became necessary and, as usual, the Germans were on the job and supplied us with Engler instruments. Various methods of interconversion of the two scales have been suggested, but the problem is not as easy as it looks, as the conversion factor is not constant throughout the viscosity range and it also varies with the character of oil.

It is to be hoped that some international standard method of measuring the viscosity of oil will be adopted, reconciling the Saybolt, Engler and Redwood scales and eliminating the periodic appearance of new proposals for determining viscosity. Only then shall we all be able to speak the same language.

DISCUSSION

This paper gives an authoritative statement of recent progress in oil burning by one who has taken a leading part in its development; there was a most flattering acknowledgment of this fact by Admiral Dyson for the Navy and by John Martin on behalf of the Shipping Board.

The Problem of the Hull and Its Screw Propeller

BY REAR ADMIRAL C. W. DYSON, U.S.N.

This paper, which will be published in complete form in a later issue of MARINE ENGINEERING, outlines the research and investigations on the relation of the hull to the screw propeller problem carried out by the author over a period of several years. In making the selection of data upon which to base formulas and design data, it is necessary to confine consideration to hulls of fine lines with propellers so placed that the chances of decrease in propulsive efficiency due to hull effect are reduced to a minimum. The propellers which are fitted to these hulls must all have practically the same radial distribution of the projected areas, must have the same general forms of blade sections, must be true to pitch, fine-edged and smooth in order to eliminate as many variables as possible from the design equations. Variations in hulls, resistance of hulls and appendages, the location of the propeller in relation to the hull are all given consideration and their effects on the design of a propeller are determined. The questions of small diameter propellers carried as deeply as possible in the cases of deep draft vessels, propellers for double enders, propellers for tunnel boats, etc., have not been touched.

DISCUSSION

This paper gives the most recent and authoritative statement of the method of powering ships and designing propellers, by one who is recognized as having unusually successful experience in this field. Commander William McEntee, U. S. N., while recognizing the great value of this method, based as it is on the performance of ships on trial, regretted that it had not been cast into a simpler and more logical form. W. W. Smith, chief engineer of the Federal Shipbuilding Company, having used the method successfully, reported that he found the method difficult to use and that further there was great difficulty in following a line of reasoning from cause to effect. It may be admitted that any method, however difficult, which gives satisfactory results is worth all it costs.

Annual Banquet

At the annual banquet of the Society, which was held at the Waldorf Astoria hotel on the evening of November 12, over 1,200 persons were present. Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Company, acting as toastmaster, introduced as the first speaker Congressman George H. Edmonds, of Philadelphia, a member of the House Committee on Merchant Marine and Fisheries, who discussed at length the provisions of the Jones Bill. The only other speaker was the Honorable John McCrate, a newly elected Supreme Court Justice of King's county, New York, who spoke on the "Limitations of the Law."

On Saturday morning the Society held an excursion, visiting the yards of the Federal Shipbuilding Company, Kearney, N. J., where the launching of a cargo vessel was witnessed.

Piston and Rings for Heavy Oil Engines

(*Concluded from page* 1003)

face which a tool always leaves on cast iron. The same treatment must be given the ring scores in the piston. The depth of these scores must be slightly greater than the thickness of the ring. The fit of the rings in the piston scores must not be too tight; in fact, it is better for the rings to be loose, for if the fit is tight the rings soon become almost a part of the piston, thus preventing any movement at right angles to the piston. Oil also burns in between the rings and the piston with the same result. One thing that has not been mentioned in making the ring is that it is necessary to just break the inner edges of the ring with a fine file when facing it. This prevents the edges striking into the corners of the ring scores should the work on the piston leave even a small fillet.

Many experiments have been made with steam engine piston rings and there is no trouble in making a steam piston tight. Professor Sweet's idea was to make a piston ring which was able to collapse, but could not expand beyond a fixed diameter. This he accomplished by making a joint in which a U-shaped piece was fitted on the inside of the ring at the joint. The key, as it might be called, fitted into two milled keyways in the ring. These two keyways were cut wider than the two projections on the key and a space was left between the abutting ends of the ring, which was cut at right angles to the ring. The key was fitted so that the outside of the ring was just the proper running fit in the cylinder. If the fit was not tight enough, the inside of the key ends were filed off and this allowed the ring to spring out to properly fit the cylinder. The idea of Professor Sweet was that if the ring could spring outwards without restraint it put considerable friction on the piston rings, which did no good, but lessened the power of the engine. The collapsing of the ring was only to provide some elasticity in caring for the expansion and contraction of the cylinder and piston.

While the design of the ring and its construction are important, more attention can be given to the composition of the metal in the rings for an oil engine. It is quite possible that some material other than cast iron can be found which will do better than any cast iron mixture.

When a hollow piston is used, the piston rod will hold the two sections together, in which case the reduced portion which would pass through a single piece piston has simply to be made longer, leaving a shoulder against which the lower half of the piston will rest. The nut on the upper end of the rod will then draw the parts of the piston tightly together, making a solid job. It is well to have the rod just above the shoulder made slightly larger in diameter than the rest of the rod, so that while a tight joint is thus obtained the lower half can be easily removed.

THE PISTON ROD

In describing the crosshead and piston (November MARINE ENGINEERING), the method of attaching the piston rod to the piston was fully described, so there is little to be said further on the subject.

The design which calls for the piston rod to be forged solid with the crosshead is one which is preferable to any other. If, however, the rod is made separately, it may be found advantageous to select a bar of the chosen grade of steel which is nearly the desired diameter of the rod and so requires only a light grinding cut to clean it up and bring it to the specified size. A rod so made wears better, as the surface of a bar is closer grained and harder than its interior.

The crosshead end of a rod made separate from the crosshead can have its thread larger than the diameter of the rod, thus insuring greater strength at this point. This cannot be done, however, on the piston end of the rod, and as a chain is no stronger than its weakest link, the enlargement of the crosshead end of the rod seems inadvisable.

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Standardization of Technical Education

A MATTER that came out incidentally in the discussion of a paper before the Society of Naval Architects and Marine Engineers is most interesting and important, and reaffirms an opinion recently given in these columns that technical education tends toward standardization. The president of the Webb Institute of Naval Architecture (formerly Webb Academy) reports that the only reason that the Institute has not already joined the company of degree-giving institutions is that they cannot now meet the requirements of the Board of Regents concerning instruction that is not related to the profession. Also it is reported that the Drexel Institute is on the way toward joining the great majority. Considering the fact that the Armour Institute did not at first grant degrees and that an attempt was soon made by the faculty of the Carnegie Institute of Technology to get into line, we may question whether any institution will be able to withstand the tendency toward standardization.

The Captain's Responsibility for His Ship's Stability

OF late years there has developed a tendency to require captains to know something of the stability of their ships. In some cases blue prints of curves of metacentric heights and other ship's properties have been furnished captains. In one case a captain inquired, "What am I to do with this?" "I don't know, but be sure to receipt for it."

Recent British books on naval architecture assert that many captains understand stability and suggest that a captain, being supplied with the heights of the metacenter, should be able to determine the metacentric height. Considering that the metacentric height desirable for a large ship is about one foot, while the height of the metacenter from the keel is likely to be 25 or 30 feet, is rather a rigid requirement. There is no question that some captains can learn to figure change of location of the center of gravity due to loading and stowage, and perhaps all ought to; but the exact determination of metacentric height is difficult for the naval architect, and an error of half a foot might occur in a captain's computation without much blame to him.

It is suggested that a more certain and a fairer way is to require the naval architect to determine the metacentric heights for all conditions of loading and stowage for the ship in ordinary service, and to give this information to the captain in the form of directions for loading, taking account of weight and bulk of cargo and locations of various kinds to keep within proper requirements. In case the captain has any question concerning stability it would be better for him to cable information and ask instructions.

The captain may always detect lack of stability from the effect on rolling. He should know the normal time of rolling and the limits of variation consistent with proper stability. Should the time of rolling increase unduly, and especially if the rolling becomes uncertain and shows a tendency to lag in recovery at the end of a roll, he should be instructed to return to port and cable for instructions.

When Is a Steam Pump Not a Steam Pump?

"WHEN is a steam pump not a steam pump?" No, this is not a silly conundrum and it does not belong in the funny column; this magazine may be funny, but not intentionally. For the answer is: "When it is a steam engine." A steam engine is run by an engineer, and an engineer must have a license; consequently no one without a license may start a steam pump when it is a steam engine. The regulations for engineers and their licenses are stiffening up, and properly so; but there must be some practical limit. A certain professor of mechanical engineering has found it convenient to get a license, and it is a question whether all the teaching staff in a steam laboratory should not be required to have licenses.

It is difficult to determine the line of demarcation between a steam pump and a steam engine. The first steam engines that worked on a vacuum and were called atmospheric engines were pumping engines. They were used to pump out coal mines because the transportation problems of those days were worse than they are now. They developed into the Cornish engine, which long held the title for fuel economy. Truly, they had a beam, but that was a matter of convenience; an off-shoot known as the Bull engine had the piston directly on the pump rod and had no beam. The valves of the Cornish engine were worked by a plug rod and it may be considered the progenitor of the direct acting steam pump.

But the direct acting compound condensing pumping engine, at one time the favorite for pumping stations of small towns, is unquestionably an engine and should have a licensed engineer, whether so required by law or not, provided any are yet in service.

Evidently a beam will not serve as a criterion, because only direct acting steam air pumps are now provided with beams; nor will a fly wheel, for a fly wheel steam pump is still a pump. Nor will size alone suffice, for an underwriter's fire pump will deliver a small brook. And yet it is undesirable that the night watchman should be required to go and wake up a licensed engineer to start a fire pump.

After all, engineers will agree that a steam pump is not a steam engine, and it should be lawful for an unlicensed oiler to start it.

Reception of Shop Visitors

IN the old easy good natured days anyone could go into a machine shop and have a look around; there might be a sign of "no admittance," but it was qualified by "except on business," and even if a foreman came to inquire over business it was easy to quiet his apprehensions. Such a free and easy system soon came to an end and visitors were properly required to go through the office and give some account of themselves; but it required a foreign war to put up a bar at the entrance with a watchman having police powers; a watchman who learned to look with suspicion on a stranger, particularly if well dressed and self-confident. The whole idea is relatively new and some establishments have not developed an etiquette to go with it; those establishments that have developed an inquiry office have a proper official who quickly and courteously finds out the business of all callers and either directs a person on his way or invites him to a cheerful waiting room. It is not necessary to dwell on the lack of system that requires a person to wait without the bar in the entrance hall, perchance furnished with a settee or two till his case can be passed on.

Council of the Naval Architects' Society

EVERY human undertaking has to be managed, and those responsible for the management must show discretion in the management, if things are to go on smoothly. The executive work of the management must be done by a small body; the real work is commonly done by one man on whose tact much depends. If the management is slack, there is confusion and waste of time; if the management is bureaucratic, those not within the circle are likely to be dissatisfied even though things go smoothly. In the affairs of the Society of Naval Architects the management is in the hands of the Council. It is obvious that a large body like the Society cannot conveniently handle any situation unless a working plan is provided in advance. If the plan is radically unsatisfactory to even a large minority, it usually cannot and certainly ought not to be carried through. If the plan is in general satisfactory, it can often be amended in the open meeting so as to suit the majority; but any large amendment is likely to be so difficult that it must be referred back to the management.

The important matter in preparing a plan is to determine so far as possible that it will be found acceptable to the meeting. The subject matter for consideration of the meeting is prepared for and discussed in the meeting of the Council in advance of the meeting of the Society. The Council is large and is representative, so that its opinion is likely to be satisfactory to the Society. The executive committee prepares the subject matter for the Council. Various ideas and propositions are presented either by members of the executive committee or by any member or members of the Society. In anticipation of the meeting of the Council all such business is sent in the form of circular letters to all members of the Council, who are asked to signify their assent, if they approve, or to propose amendments, if they see fit. In the light of this correspondence the executive committee can usually forestall the opinion of the Council and prepare the business to meet their approval. Any proposition that the Council is unwilling to propose to the Society is properly laid aside. After full discussion in the Council, with such amendments as may be approved by them, the matter is put into form for presentation to the Society. The executive committee is purposely made up mainly of persons who can readily attend meetings so that action on any matter can be had without delay. The executive officer of the committee is the secretary whose tact and good sense are a dominant factor in the good management of the business of the Society.

Recess Shipping Board Appointments

TO say that the list of commissioners recently appointed to the Shipping Board by President Wilson is a disappointment is putting the case mildly. If any word of approval of the President's choice has appeared in the public press, it has escaped our notice. Among the shipping, shipbuilding and allied interests the sentiment is bitter against any further toying with the Shipping Board as a political football. Not only have the present appointments been delayed for five months, but with the exception of commissioners Benson and Donald, the men selected for this important service, however qualified they may be in their own particular spheres of activity, lack any technical knowledge of shipping affairs. Moreover, the political flavor of the appointments is too obvious to deceive the most liberal critic. If there is any national service which should be non-partisan and based upon merit alone, it is the control of the country's shipping affairs—particularly in foreign trade. Ample opportunity has been given to show the harm that can be done by entrusting the direction of the American merchant marine in the hands of men who lack a first hand knowledge of the intricate affairs of shipping. With possibly the two exceptions mentioned above, it is inconceivable that the new appointments to the Shipping Board will be ratified by the Republican Senate that is about to convene.

Electrically Propelled Merchant Vessels

TO a New York shipbuilder falls the distinction of making the first installation of electrical propelling machinery in a passenger ship. Elsewhere in this issue will be found a complete description of the vessel and her machinery. With a displacement of 3,580 tons on a 17-foot draft, the vessel attained a sea speed of 17.28 knots on her trials, the machinery developing approximately 3,000 horsepower. This installation is of special interest, not only because the *Cuba* is the first electrically propelled passenger ship in the world, but because the electrical propelling machinery is practically identical with that which is to be installed in the five new revenue cutters building on the west coast. The appearance of the first electrically driven passenger ship follows closely upon the entrance into deep sea service of the first electrically propelled American cargo steamer which was described in our last issue. Two duplicates of the cargo vessel are now being equipped with electrical propelling machinery and designs are being prepared on the Pacific coast for a large electrically driven passenger vessel.

LETTERS TO THE EDITOR

Information Wanted Regarding Service Given by Condenser Tubes

A joint investigation is being undertaken by the General Electric Company, Schenectady, N. Y., and the Diamond Power Specialty Company, Detroit, Mich., on the subject of the life of condenser tubes. The investigation is undertaken with the object of determining the possibilities of utilizing calorized copper tubes in this field.

Calorizing has, of course, proved its value in preventing oxidation of soot blower units, pyrometer protection tubes and other equipment at points of high temperature. What is not so generally known, however, is that calorizing has been utilized successfully for some time under certain conditions as a means of preventing corrosion.

Information is desired from engineers engaged in both stationary power plant and marine work respecting the service which they are getting from their condenser tubes. The co-operation of such engineers is requested and will be very greatly appreciated. In order to be of value, the reports sent in should contain as specific data as possible on the following points: (a) Metal of which tubes are made; (b) size and length of tubes; (c) life of tubes.

Communications on this subject should be addressed to the writer, care of the Diamond Power Specialty Company, Detroit, Mich.

Detroit, Mich. Robert June.

Cargo Motorships Versus Steamships

With considerable interest I have read the article "Cargo Motorships versus Steamships" by Professor Charles E. Lucke published in the September and October issues of Marine Engineering. In the October issue on page 837, under the heading "Maintenance," the author states: "Very little information is available for geared turbine steamers, but it seems fair to assume that the upkeep cost would be less than for reciprocating engines. In view of the fact that most of the expense is due to boilers, it seems that the fair proportionate figure would be $8,000 for the geared turbine against $10,000 for the reciprocating engine."

The marine geared turbine, including its necessary auxiliaries, represents a more refined type of machinery installation than the reciprocating engine. When the comparatively high speed at which turbines operate, the small clearance allowed and the importance of maintaining proper lubrication to the bearings and gears are considered, it will be seen that a better class of men are required for the operation of turbines than are necessary for the operation of reciprocating engines.

Sufficient engineers qualified for the operation of marine geared turbines are not obtainable today, whereas engineers for reciprocating engine operation are more plentiful. This scarcity of qualified turbine engineers is an important factor in the repair costs of turbines. In many cases the inexperience and lack of proper turbine repair equipment of ship repair yards have resulted in the practice of having the turbine and gear manufacturers perform the necessary major repairs at their plants, and the transportation involved, with its consequent delay, is costly. On the other hand, shops and experienced workmen for reciprocating engine repairs are in abundance and the shops are better equipped and situated for economical repairs.

In making a comparison of repair costs, it is well to take into account all the factors that exist, and those who have had turbine and reciprocating engine repairs performed recently realize how much more costly turbine repairs are. While repair costs will no doubt vary with the type and manufacture of the turbine, it is believed that in general the cost of marine turbine repairs will exceed that of the reciprocating engine. It is also believed that the cost of repairs will in a large measure be proportionate to the degree of refinement of the machinery installation.

The difference in repair costs between turbines and reciprocating engines will not materially affect the final result in the comparison between motorships and steamships, but it would be interesting if Professor Lucke would state the basis upon which the assumption is made that the upkeep cost of the turbine steamship would be less than for reciprocating engines.

Hackensack Heights, N. J. Carl E. Petersen.

Speed of Diesel Engines

I note with interest on page 934 of the November issue two editorials under different headings that are not connected in treatment but which, as a matter of fact, have a great bearing on each other. The paragraphs I refer to are "Loss of Efficiency with High Speed Propellers" and "Increasing the Power of Diesel Engines."

Having had a great deal to do with propeller designing and applications, and having made considerable study of the prime motive question relative to ships, I have deduced the general conclusion that the Diesel engine designers have striven for efficiency of their engine rather than for the total efficiency of the ship which they are to propel.

Diesel engines to compete with geared turbines or reciprocating engines in merchant ships with coarse block coefficients will have to be produced at shaft revolutions that are consistent with the type of hull they are to drive, and up to the present time the twin screw installation has seemed the most logical for either converting such merchant ships or for the installations in new designs because of the high speed at which engines are required to run and the inability of the propeller in a single unit installation, at the speed the engines are designed to run, to show any sort of propulsive efficiency.

In order to reduce the total cost of the Diesel installation, a single unit must be resorted to, as I see it, which will revolve the propeller at speeds within its scope, and until that time the operation charges of Diesel engine driven vessels cannot be made to indicate the true value of this type of prime mover.

The electric drive installations made by the General Electric Company for the steamers *Cuba* and *Eclipse* were held down to 100 revolutions, and while this is 15 revolutions higher than the average turbine installation, the efficiency loss does not become serious, but the tendency to hold the revolutions down indicates that the electric drive people have in mind the ultimate comparison with the reciprocating engine and have endeavored to provide for the shipowner the ultimate economy. The Diesel engine designers, as I see it, must follow suit or lose a portion of their decided advantages.

New York. S. D. Levings, Vice-President,
Columbian Bronze Corporation.

Steamboating on the Mississippi

Up and down the "brown Mississippi that rushes along from the snow to the sun" there used to float famous steamboats whose splendor was a marvel in the way of comfort and luxury for those bygone days, and even today the names of the *Robert E. Lee* and the *Natchez* are remembered by many as all that was palatial in travel. On the early steamers of the rivers were rooms for its passengers and they were given the names of the various states of the Union (the largest or main saloon was called the "Texas") and the name "state room" thus had its origin.

Mark Twain has made the river life known to us in a way which no other writer has even approached. The great race between the two boats named is talked of today by those whose hair is white but whose memory still serves. Fat pine was the fuel, and, if tradition is to be believed, when a race was on, fat pork was thrown into the furnaces of the boilers to help in keeping up steam, and, of course, a nigger was perched on the safety valve lever. Those days are gone, yet in many a Southern home and hostelry may be seen pictures of the famous river boats with the flames belching from the tops of their smoke stacks.

Of those who took part in these stirring events few are left from whom we can hear first hand accounts of just how the trips up and down to St. Louis were made, and only the other day one of the last of the great river men wrapped the draperies of his couch about him and laid him down to pleasant dreams. He was Captain Peter Peppers, first mate of the *Natchez* when she made her famous race against the *Robert E. Lee* to St. Louis and also when she made her record cotton carrying trip. During the Civil War Captain Peppers took to blockade running and did well at it. He mourned the decay of the river traffic, but was a firm believer that the great river would again come into its own. He knew the "coast," as they call the river along its border, as few ever knew it, and he was believed to be able to smell a snag or a sand bar in the darkest night. Those who knew him say that to talk to him of old river days was more interesting than seeing a good play, and now that he has "made his last landing" the river will be lonely indeed.

New Orleans, La. W. D. Forbes.

NEW BOOKS

Applied Naval Architecture

REVIEWED BY C. H. PEABODY, DR. ENG.

Applied Naval Architecture. By W. J. Lovett. Size, 5½ by 8¾ inches. Pages, 654. Tables and diagrams, 361. New York, 1920: Longmans, Green & Company.

In the preface the author announces that this book is intended for the use of those engaged in the design and construction of moderate speed merchant vessels, and it undoubtedly presents the matter in the way he finds interesting from his own experience. It will be useful for a student to read, after he has completed a theoretical course of instruction, because it will give him a very different view of the subject from that found in the standard text book.

The first chapter is on bilging, discussing the bilging of a rectangular box with and without compartments and then gives in detail the computation for the bilging of an actual ship; here and throughout the book the author gives copious computations largely in tabular form. For some reason the tables are photographed from hand-written copy, and, though legible, are annoying to use. This method of attack allows the author to place the most recent work in naval architecture in front; he gives a very good résumé of the bulkhead committee and examples of determination of floodable length.

Next the author gives Board of Trade Regulations at great length, and then is ready to discuss design. Conforming to his restriction of his work to moderate speed, he announces that his speed length ratio is 0.5 or thereabouts. For such speed and type of vessels the usual method of design is apt to be that set forth by the author, namely, all the dimensions and proportions for the new ship are assumed and then the designer makes computations to see if they fit, and to find if there is any advantage from minor modifications. This chapter is followed by a discussion of freeboard; here again the author gives recent work of committees.

There has grown up a tendency to demand that the captain shall know something about his ship; not how to navigate her, but what her scientific properties are. A chapter is here given on ships' curves—like curves of centers of buoyancy, metacentric curves, etc. Evidently the captain is supposed to have these curves and use them, and "any captain should be able to calculate for himself the approximate height of the center of gravity in any condition of loading." Fortunately, the matter of stability is brought down to one plain requirement that the metacentric height shall be one foot. The recommendation of one foot is sensible and simple, but it appears to be a little hard on the captain that he should be responsible for it.

There is a good discussion of launching, following the usual British method, including the effect of camber of the ways.

The discussion of power adopts Froude's circle notation in connection with the use of information from models. The author makes the common error of assuming that Tideman made experiments on surface friction; his work being monumental and in Dutch, few have found his statement that he did *not* make determinations of surface friction. The matter of wave interference is concisely stated. The discussions of shallow water resistance and of the trochoidal wave are very conservative.

Considerable space is given to steering and computations for the rudder and stock, attention being called to the fact that the most unfavorable conditions are likely to occur during backing.

Half way through the book the author takes up stability and trim, subjects which come near the beginning of the usual text book. Since his attention is given to the application rather than the theory of naval architecture, there is no complaint that his treatment is brief and conventional. Some space is given to grounding on hard bottom or in mud.

Following the usual English practice, the author opens his discussion of strength by a general survey of strength of materials, riveting and girders, including lattice girders. Why this is considered necessary is curious, as no one unfamiliar with mechanics should undertake to read the strength of ships. The computation for bulkheads appears to be confused, if not doubtful. A valuable feature is the statement of experiments by aid of Stromeyer's strain indicator on the *Wolf* showing less stress than given by the usual calculation, although the vessel was purposely placed in trying conditions at sea, the conclusion being that conventional computations for longitudinal strength of ships are sufficient. Reference is also made to Bruhn's work on transverse strength. A subject not usually found in text books, namely, the strength of caissons for dry docks, receives a general treatment. In the chapters on strength are given tables of weights, moments of inertia, etc.

A useful chapter is included on tonnage by the methods of Great Britain and other nations, and also for the Suez and Panama Canals. The book closes with a table on weights, stowages and general tables, including logarithms.

Seaman's Handbook for Shore Leave

An important little publication for American merchant seamen, whether in the engine room, deck force, or stewards' department, and quite as valuable to officers as to men below the licensed grades, is "The Seaman's Handbook for Shore Leave," a compilation of specific and original data regarding facilities for service to sailors in 325 of the ports of the world, which is soon to appear in a revised edition of 164 pages, in vest pocket size.

The book is published by the Social Service Bureau, United States Merchant Marine, under the direction of the Bureau's chief, Mrs. Henry Howard, whose headquarters are at the Boston Custom House.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Rivets in Stiffening Ring Spaced to Clear Studs

Q. (1108).—I would like to have you settle a dispute between *A* and *B*. *A* says that it is practical and proper to space and drive countersunk head rivets through bilge and doubling plate in way of sea chest to hold calking of both plates where "cut-out" comes for strainer.

A. (1108).—The best practice as exemplified by the detail plans of several large building yards working to United States Navy specifications supports *A*'s contention. A heavy cast steel liner is worked round the opening or "cut-out" in the shell plating. This liner is about the width of the sea

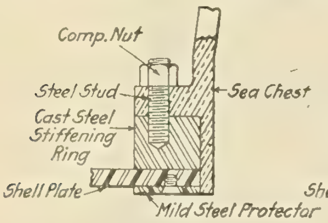


Fig. 1.—Section Through Stud

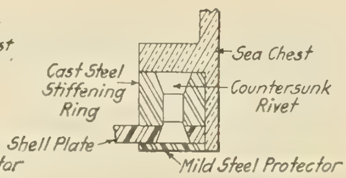


Fig. 2.—Section Through Rivet

chest flange and is riveted to the shell by countersunk head and point rivets. The sea chest flange is attached to the liner by steel studs so spaced as to clear the rivets through the liner. The studs are carefully fitted so as not to extend entirely through the liner (see Figs. 1 and 2).

Forces Acting on Keel Blocks While Docking Vessel

Q. (1107).—When a ship with considerable drag is being docked in a dry dock, say with draft 20 feet forward and 26 feet aft, the after end of the keel touches the blocks first, and after touching, as pumping down continues, the extreme after block on which the keel is resting tends to tip over aft, indicating that there is a force tending to move the ship aft until she lays all along on the keel blocks.

Please explain the cause of this, also give the magnitude of this force relatively to some element of which it is a component.

A. (1107).—When the vessel is entirely afloat just prior to her keel's touching the keel blocks, her center of gravity is in the same perpendicular line to the water surface as her center of buoyancy. This is essential to her condition of equilibrium. At any instant during pumping down, after her keel aft has touched but before it lies all along on the blocks, the vessel is supported by two forces—one the keel block acting at the after extremity of the keel, and the other the vessel's buoyancy. The point of application of this latter force has moved forward from its position when the vessel was afloat due to the decrease in draft aft. The buoyant force continues to act upward and the weight of the vessel to act downward at its original position both along lines perpendicular to the surface of the water.

Therefore we have three forces acting upon the vessel—the buoyant force forward, the force exerted by the keel block aft, and the weight just aft of the buoyant force. Now the buoyant force and the ship's weight are both acting along lines perpendicular to the surface of the water. Hence, the ship being in equilibrium, the supporting force exerted by the after keel block must also act perpendicular to the water's surface and there can be no fore and aft component tending to tip the keel block aft.

The foregoing is a theoretical statement of the case and is believed to represent the actual condition very closely. External forces may, however, operate to produce extraordinary results. For instance, during pumping down every effort is made to keep the vessel stationary in both the transverse and fore-and-aft direction. This is done by means of lines and side shores. Even where these are handled with great care it is possible to introduce forces, not considered above, which might slightly affect or tend to affect the vessel's position. Thus an undue strain on lines leading aft might produce slight motion astern, resulting in the tipping tendency in the after keel block referred to. Ordinarily, however, such forces are negligible in amount and always they are indeterminate in both amount and direction.

Horsepower of Internal Combustion Engines

Q. (1109).—Please explain formula for horsepower of internal combustion engine $\frac{P \times A \times L \times \text{explosions}}{33{,}000}$ and give example worked out.

J. P. H.

A. (1109).—The formula to which you refer is usually written in the following form:

$$\text{Horsepower per cylinder} = \frac{P \times A \times L \times \frac{N}{q}}{33{,}000},$$

where

P = mean effective pressure in pounds per square inch during the power stroke.
A = net area of the piston face in square inches.
L = length of stroke in feet.
N = number of revolutions per minute.
q = number of revolutions per power stroke.

In the case of the ordinary 4-cycle engine, where alternate downward strokes are power strokes, $q = 2$ and the expression for horsepower becomes

$$\frac{P \times A \times L \times N}{2 \times 33{,}000}.$$

In the case of the ordinary 2-cycle engine, where each down stroke is a power stroke, $q = 1$ and the expression for horsepower becomes

$$\frac{P \times A \times L \times N}{33{,}000}.$$

The above represents the result of applying the principles, "work is the product of force by the distance through which it acts, and power is the rate of doing work or the quotient of the work divided by the time in which done."

The force is furnished by the explosion of the gases in the cylinder. Its amount is determined by the net area of piston face in square inches and the mean effective pressure of the explosive gases during the stroke $= PA$.

The distance moved is that traveled by the piston under the pressure of the explosive gases during one minute, which is $L\frac{N}{q}$. $\left(\frac{N}{q}\right.$ really is the number of explosions per minute.$\left.\right)$

The number 33,000 expresses the number of units of work (in foot pounds) which the most powerful dray horse could perform in one minute. It was fixed by Watt at a time when the steam engine was taking the place of the horse in mining and other kinds of machinery. The expression of the power of an engine in terms of that of a number of horses accordingly conveyed a fairly definite meaning. The standard thus established has been accepted for both land and marine machinery ever since. The following example will serve to illustrate the application of the above formula:

Given a six-cylinder, four-cycle gas engine having a cylinder 10 inches by 11 inches operating with a mean effective pressure of 65 pounds per square inch at 460 revolutions per minute. Required the horsepower:

$$P = 65,\ A = 78.5,\ L = 11/12,\ N = 460.$$

$$\text{Horsepower} = \left[\frac{65 \times 78.5 \times 11/12 \times \dfrac{460}{2}}{33{,}000}\right] 6 = 196.$$

Pitch of Propeller

Q. (1115).—Explain how (the correct way) to find the pitch of a propeller. J. P. H.

A. (1115).—In "Practical Marine Engineering," seventh edition, pages 606, 607, 608 and 609, Admiral Dyson describes in detail the methods used and explains the principles involved in measuring the pitch of a propeller.

If you are particularly interested in small boat propellers, a method of pitch measurement especially suited to this type is described by A. E. Potter in a book published by the Rudder Publishing Company in 1905 and entitled "On Modern Screw Propellers."

Reversible Propeller

Q. (1116).—Please describe a reversible propeller and explain how it works. J. P. H.

A. (1116).—In cases where vessels are intended to utilize both or either sail and machinery for purposes of propulsion, it is desirable and, in fact, essential to eliminate the drag resulting from an idle screw when traveling under sail alone. This has been done by withdrawing the screw entirely from the water by fitting a screw having feathering blades capable of being turned so that the blades lie nearly in the stream lines, and by fitting a two-bladed screw in a carefully designed aperture in the dead wood so as to be entirely masked thereby at the will of the commanding officer.

In addition to its use upon vessels employing both sail and propelling machinery, the reversible screw is used on small motor-driven craft for backing without reversing the engine.

The original patent covering reversible screws was taken out in 1844. It contemplated two blades having shanks fitted into the boss. Short levers were secured to the shanks within the boss. These levers were linked to a sliding collar outside the boss. This collar was capable of fore and aft motion and was operated by bell crank levers from within the vessel.

At a somewhat later date designs were developed which obviated the necessity of fitting external bell cranks, collars, etc.

At the present time reversible screws involve the fitting of blades on shanks to large hollow bosses. These shanks are rotated either by internal bell cranks actuated by shafting working inside the main propeller shaft or by an internal shaft carrying worm threads or bevel gears.

The Bureau of Navigation, Department of Commerce, reports 119 sailing, steam, gas and unrigged vessels of 226,603 gross tons built in the United States and officially numbered during the month of October.

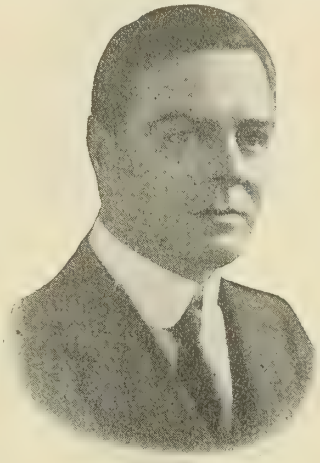
PERSONAL MENTION

F. L. CHAMPAGNE has resigned as superintendent of hull construction at the Sparrow's Point plant of the Bethlehem Shipbuilding Corporation. Mr. Champagne has been connected with the company since 1899.

JOHN L. COLLYER, superintendent of hull construction at the Sparrow's Point plant of the Bethlehem Shipbuilding Corporation, has offered two scholarships for the courses in industrial organization and hull construction at the Johns-Hopkins University, Baltimore, Md.

WALTER MURTAUGH has been appointed New York representative of the Bath Iron Works, Bath, Me. This company has just opened a New York office.

JAMES LEE ACKERSON, former vice-president of the Emergency Fleet Corporation, who was recently named second vice-president of the Merchant Shipbuilding Corporation, has commenced duty at the Chester yard. He will also be one of the directing heads in the Philadelphia offices. Mr. Ackerson graduated from the United States Naval Academy with the class of 1901, and since that time has been more or less actively engaged in the assembling of ocean going vessels. He saw four years' service at sea, having held an appointment at the New York Navy Yard. He was also connected with the Naval Department of Design and Construction, and in addition to this rounded out a term of service in the Navy Yard at Mare Island, California, where he was in charge of new ship construction. While still holding the rank of commander in the Construction Corps of the United States Navy, he was appointed vice-president of the Emergency Fleet Corporation, from which post he resigned early this year. He also resigned from the naval service in February.



J. L. Ackerson

GEORGE J. SANTA CRUZ, who has been appointed district director of the United States Shipping Board for the South Atlantic division, left recently for Savannah, Ga., where he will have supervision over all operations of the Shipping Board from Wilmington, N. C., to Tampa, Fla.

RALPH B. FERRIS has resigned as naval architect from the Atlantic, Gulf and Pacific Company, Midwood, Brooklyn.

C. H. MARSHALL, who has been manager of the operating department of the Shipping Board at New Orleans, has been made Shipping Board agent at Galveston, Tex.

FRANK J. REYNOLDS is at the New York office of the Standard Shipbuilding Corporation, replacing Captain C. C. McCarthy, who recently resigned to organize the American International Steamship Company.

CHARLES H. MILLER, assistant to J. A. Ubsdell, vice-president of the Great Lakes Engineering Works, has resigned on the reorganization of the company and has started the Wolverine Sales Company at Detroit. He was formerly secretary to Theodore E. Ferris.

C. S. Hermann has resigned as chief chartering executive for the Shipping Board and has announced that he will conduct a general steamship brokerage company, with offices in the Whitehall building, 17 Battery Place, New York.

T. C. Hammond recently resigned from the Merchant Shipbuilding Corporation to accept a position as general manager of the Mutual Shipping Service Corporation, 35 South William street, New York.

Carl C. Lorentzen has recently accepted the appointment as district superintendent for the United States Shipping Board in the district including all Baltic and Scandinavian ports. Mr. Lorentzen began his career as an apprentice in the blacksmith and marine engine shops of various Danish navy yards and after two years of this work entered the Danish Naval College for shipbuilding and marine engineering at Copenhagen, from which he graduated as an assistant naval engineer. The next eight years he served in the Danish Navy as a marine engineer, and in the Burmeister and Wain shops. Part of this period was spent in Scotland in connection with British shipbuilding, and in the United States inspecting American shipbuilding practice. While in Scotland he did post graduate work at Birmingham University. Since then he founded a marine engineering school in Copenhagen for training Danish marine engineers. In 1900, although a Danish citizen at that time, he was attached to the United States Commission in Paris in charge of the government engineering exhibit at the Paris Exposition. From 1903 to 1909 he was a member of the faculty of the school of applied science at New York University, during which period he originated and organized the American-Scandinavian educational movement. During the war he served as chief engineer on Shipping Board vessels sailing between New York, Baltic and Scandinavian ports. Since April 1, 1920, until his present appointment, he has been a representative of the Staten Island Shipbuilding Company, New York.

Carl C. Lorentzen

George A. Brown, surveyor of the American Bureau of Shipping, recently sailed for Havre to represent there the Bureau for northern French ports.

Hermann Winter has been appointed manager at Hamburg for the American Line of the International Mercantile Marine Company, of New York. He will relieve J. J. McGlone, assistant to the president of the International Mercantile Marine Company, who has been in Hamburg since December, 1919, when the American Line re-established communication with Germany.

W. C. Foley has been appointed chief surveyor of the American Marine Insurance Syndicate. His experience includes twelve years with the Newport News Shipbuilding & Dry Dock Company, where he served as chief hull draftsman, as naval architect, and as assistant superintendent. He also has been four years abroad supervising the construction of submarines for the Austrian government. He then became associated with the Lake Submarine interests and later was made vice-president and general manager of the California Shipbuilding Company, of San Pedro, Cal.

Captain J. Howard Payne, former Seattle agent of the Shipping Board, has been made assistant director of the Seattle district agency of the sea service bureau of the Shipping Board.

John A. Donald, commissioner of the United States Shipping Board, has accepted the appointment for a new term in the same capacity with the Board.

L. C. Wilson, for the past two years general sales manager of the Chain Belt Company, Milwaukee, Wis., has been elected secretary of the Federal Malleable Company, West Allis, Wis. He will be succeeded as sales manager of the Chain Belt Company by Clifford F. Messinger.

James W. Ryan, former special assistant to Attorney General Palmer and attorney for the United States Shipping Board, has been appointed assistant United States District Attorney for the southern district of New York, in which position Mr. Ryan will conduct the admiralty litigation of the Shipping Board, War, Navy and other governmental departments.

Colonel Eugene R. West has been appointed acting counsel for the United States Shipping Board Emergency Fleet Corporation for the northwest district, with headquarters at Seattle, in which capacity he will carry out the legal formalities connected with the closing of the government shipbuilding programme in this district.

Lawrence J. Brengle has been appointed as underwriter for the American Marine Insurance Syndicate *B* and *C* sections. Mr. Brengle has been connected with the marine insurance business for many years and was for some time adjuster for Johnson & Higgins. He has recently been with the North American Insurance Company in its New York office.

Lord William James Pirrie, prominent in the British shipping industry, is at present head of a commission making an extended tour of the United States investigating the resources of fuel oil in this country. Lord Pirrie has been with Harland and Wolff, Belfast, since 1862. In 1878 he was taken into the firm as a partner, and has been chairman of the board of directors for many years. In March, 1918, he became controller general of merchant shipping of Great Britain and served in this capacity until after the armistice was signed.

Lord William James Pirrie

John J. Lamb has been appointed safety engineer at the headquarters office of the National Safety Council, Chicago, succeeding R. H. Guerrant, who has taken up sales engineering work with the Industrial Appliance Company, of Chicago.

W. Woodward Williams, vice-president of the Reading Iron Company, Reading, Pa., has resigned from that concern to become assistant to the president of the Pittsburgh Gage & Supply Company, Pittsburgh, Pa.

A. B. Way, until recently secretary and general manager of The Bridgeport Chain Company, has become affiliated with The Chain Products Company, of Cleveland, Ohio, in the capacity of district sales manager for New England, with headquarters at the company's New York office, 150-152 Chambers street.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

KERMIT ROOSEVELT HEADS OWN STEAMSHIP COMPANY

Concern With $1,000,000 Capital Plans Operations "On a World-Wide Scale"

Among the recent prominent developments in the shipping field was the formation, under a Delaware charter, of the Roosevelt Steamship Company, capitalized at $1,000,000, the incorporators being Capt. Kermit Roosevelt, Russell Goldman and Max Zaliels. The incorporation papers, filed at Dover, Del., gave little information regarding the new concern beyond its aim "to build, own and operate ships."

Russell Goldman is a director in the C. A. Colman Company, dealers in cotton goods at 74 Worth street, New York City. Mr. Zaliels is associated with Herman Goldman, with law offices at 120 Broadway.

"The Roosevelt Steamship Company plans to operate on a world-wide scale," it was said at Mr. Goldman's office. "It plans to acquire ships and to build if necessary."

The formation of the corporation marks the entrance of Captain Roosevelt into the maritime field "on his own." Up to the present, although some time in the shipping arena, he has appeared merely as an official of various companies.

Among these companies were the American Ship & Commerce Corporation, the holding company of the Cramp Shipbuilding Company, and the Kerr Navigation Company, which Mr. Roosevelt joined in September, 1919, as secretary. Last October he resigned, shortly after the W. A. Harriman interests had acquired the holdings of H. F. Kerr and A. E. Clegg in the Kerr Navigation Company, and the subsequent sequestration of Federal agents of $4,900,000, the proceeds of the deal.

Captain Roosevelt, then vice-president of the Kerr Navigation Company, saw in the transfer of the Kerr stock to the Harriman interests a possibility that the Hamburg-American Line might turn the transaction to its benefit. In a published statement he bitterly criticised the seizure of the $4,900,000 by Federal agents, who acted on the theory that taxes might not be paid on it, declaring that it was a coup engineered by the Harriman combination.

Maj.-Gen. George W. Goethals was president of the American Ship & Commerce Corporation at the time that Capt. Roosevelt was secretary.

MAY MEAN NEW CABINET DEPARTMENT

Shipping Board Developments Likely to Bring Administrative Change

Investigation of Shipping Board operations by the Walsh Committee, according to the National Mercantile Marine Association, involves not so much the policies directed by the Merchant Marine Act, as the application of policies adopted by the Board under the law. The purpose of the committee apparently is to bring about administrative changes, rather than secure a revision of shipping legislation. A feature of the situation has been the desire of Admiral Benson, as chairman of the Board, to have the committee go thoroughly into all phases of activities, and to this end he has offered all documents and other information available to the Board.

Irrespective of the evidence which the committee is able to secure to support its charges, there is a feeling in some quarters in Washington that one of the results of the investigation will be a recommendation for a Department of Marine, with a seat in the Cabinet. This opinion seems to be based upon the feeling that the party in power is responsible for the activities of the Board, and the head of the organization should be directly under the supervision of the President.

On the other hand, there are the opinions of Admiral Benson and others that the Board will ultimately assume the relation to shipping that the Interstate Commerce Commission bears to the railroads.

For Agreement on Rates

The recent drop in ocean freight rates, bringing the income of vessels close to the cost of operation, has led Admiral Benson to believe that the only solution of the situation is a world-wide agreement on shipping rates and regulations, tending towards uniformity of action and against rate wars. No steps have been taken by the Shipping Board to bring about this result, which is believed to be a matter for diplomatic action. Admiral Benson has stated that he would consider such a development favorably.

NEW ENGINEERING FIRM

Wide Maritime Field Covered by Organization of Experts

The Maritime Engineering & Sales Corporation, incorporated in September of this year, has established its principal offices at No. 2 Rector street, New York, and will conduct a steamship brokerage and marine engineering business, specializing as consulting engineers for and in the sales of auxiliary and deck machinery and equipment, cargo-handling gear, and Diesel and electric propulsion of ships. Branch offices or agencies will be established in the Great Lakes district, Atlantic coast ports and the Gulf district.

Arrangements have been made with the Allan Cunningham Company, Inc., that the new corporation will be sole Eastern distributors of the well-known Cunningham marine machinery and equipment, the Cunningham electric machinery especially having gained national recognition among shipbuilders and operators.

Mr. George H. Jett, who has been elected president and treasurer, brings to the firm a large engineering and marine experience. Previous to the war he was engaged in electrical and marine engineering fields on the Pacific Coast. During the war he served first as engineer officer on the *South Dakota,* and later as aide to Admiral H. P. Jones, and as repair officer at Newport News, in charge of repairs to vessels of the cruiser and transport force. For this service Mr. Jett received exceptional commendation and recognition from both the War and Navy Departments. Since resigning from the Navy, and until July of this year, Mr. Jett was connected with the Construction and Repair Department of the United States Shipping Board.

Mr. I. F. Halton, vice-president and secretary, has a wide acquaintance in marine circles. He was formerly president of the Bennet Flue Blower Company, the pioneer manufacturers of marine soot blowers.

Mr. E. H. Le Tourneau has recently joined the staff of the corporation as chief engineer. He is a graduate of the University of Minnesota, and is an electrical and mechanical engineer of broad experience, having been engaged for a number of years previous to the war as a designing and constructing engineer in the electrical, mechanical and marine fields on the Pacific Coast. During the war he served as officer in the Navy on active duty at sea, receiving unusual recognition from the Navy Department. More recently Mr. Le Tourneau has been connected with the United States Shipping Board.

BOARD CONTRACTS ENDED

Six American Shipyards Finish Their Contracts

The Mobile Shipbuilding Company, the Western Pipe & Steel Company, near Los Angeles, Cal.; the Atlantic Corporation, Portsmouth, N. H., and the Pensacola Shipbuilding Company, which combined built 395,400 tons of vessels for the Shipping Board, delivered the last ships called for by their building programme during October. The Providence Engineering Corporation, in delivering the *Bayspring*, the tenth oceangoing tug for the Shipping Board, completed its work for the Government.

The Western Pipe & Steel Company built a total of eighteen ships, aggregating 156,400 deadweight tons. The last ship constructed was the *West Carmona*, an 8,800-ton cargo carrier, which was delivered on October 26.

The Pensacola Shipbuilding Company, at its Florida plant, completed its contract of ten 9,000-ton freighters with the delivery of the *Bayou Chico* on October 15. The company made arrangements to purchase four of its ships, but later the deal was called off.

The Atlantic Corporation sent the *Pagasset* out for her sea trials on October 27, and she was accepted by the Emergency Fleet Corporation's representatives. The *Pagasset* was the tenth ship constructed for the Government's account, and with her delivery the last contract was fulfilled.

The Mobile Shipbuilding Company produced a fleet of eight 5,000-ton steel cargo carriers for the Emergency Fleet Corporation. The *Atlanta of Texas* was the eighth ship to be delivered. Prior to the construction of the steel vessels the Mobile plant turned out six composite steamers of 3,500 deadweight tons each.

The last of the Government vessels building at the Chester (Pa.) yard of the Merchant Shipping Corporation was scheduled to be launched late in November, and the ways will be filled with private contract vessls for the following owners: Union Oil Company (Delaware), two single screw tankers, 10,000 deadweight tons each, triple expansion vertical inverted cylinder reciprocating engines; Tide Water Oil Company, two tankers of same type and tonnage as Union Oil Company; Shawmut Steamship Company, two single screw combination passenger and cargo boats, 10,500 deadweight tons each, Westinghouse cross compound turbines with double reduction gears; American Hawaiian Steamship Company, two twin screw freighters, 11,000 deadweight tons each, Diesel engines.

New Oriental Company Vessel

The steamship *Oritani*, the second fruit steamer built in Brooklyn, was launched at the yard of the Tebo Yacht Basin Company, foot of Twenty-third street, Brooklyn, November 6. The *Oritani* is the second vessel built by the Todd Shipyards Corporation for the Oriental Navigation Company. Like her sister ship, the *Ormes*, she is of 1,200 deadweight tons, 227 feet over all, 33 feet 8 inches beam and 16 feet in depth. She is an oil burner equipped with the new Todd mechanical oil-burning system, with triple expansion engines of 1,400 indicated horsepower. The *Oritani* was sponsored by Mrs. Julian P. Gardner.

Submarine Boat Company's Ships Declared Seaworthy

Officials of the Submarine Boat Corporation, in a statement, have taken exceptions to testimony given before the committee investigating Shipping Board affairs by Thomas H. Purtell, who said he was an inspector of hulls in the corporation's yard in 1918, and described riveting work there as "fierce."

The statement claims that the vessels, the hulls of which Purtell testified he inspected, only recently have been examined by the department of the superintending engineer and found to be entirely tight and seaworthy.

The corporation officials say the ships in question have been through severe tests at sea, and are now reported by their masters and engineers to be in no need of repairs, which reports they claim should show Purtell's testimony to be unfounded.

Cleared of Monopoly Charges

Federal Judge Mayer has decided that Walter Moore and fifty-eight other defendants, including thirty-eight steamship lines, were not guilty of conspiracy to form a monopoly in restraint of trade, in violation of the provisions of the Sherman Anti-Trust Act.

The conspiracy alleged related to an agreement between the steamship lines and the members of the Steamship Freight Brokers' Association, whereby the steamship companies agreed to pay brokerage only to such brokers as were members of the Steamship Freight Brokers' Association.

A second account in the indictment charging restraint of interstate and foreign commerce has also been quashed by the court, after hearing arguments of counsel on the demurrer to the indictment.

Suits By Morse Companies

Suits for sume aggregating $2,378,256 have been filed in the Supreme Court against the United States Shipping Board and the Emergency Fleet Corporation, by four steamship companies controlled by the United States Steamship Company, 50 Broad street, New York, of which Charles W. Morse is president, for damages caused by an alleged breach of contract on the part of the defendants. Each of the companies owns a vessel bearing the first part of the corporation's name, and the United States Steamship Company owns the Virginia Shipbuilding Corporation, which also figures in the suit. The suits are brought by the Binghamton, Huron, St. Paul and Minneapolis steamship companies.

THIRD MARINE SHOW

National Marine League Plans Big Display in January

The National Marine League is in the midst of lively preparations for a marine show in New York in January, 1921. The outstanding feature in the first New York show was the arousing of interest in the general public—the bringing of a great mass of American voters to a state of shipmindedness. The interest which was so evident on all sides was instrumental in developing the second project—a marine show in Chicago, 1,000 miles from tidewater.

P. H. W. Ross, president of the National Marine League, who presided at the Chicago Show, was responsible for much of the success of the undertaking. His energy and enthusiasm proved definitely that the National Marine League exists to serve both the inland and oceanic necessities of the United States.

The Chicago Exposition had a great significance in that it represented the Marine East fomenting the great mass of people in the Inland West. It was as the turning of a key, the throwing open of the door to the seven great inland States—Illinois, Indiana, Iowa, Ohio, Missouri, Michigan, Wisconsin. These States comprise the most wonderful producing district in the world.

Being set, as it were, almost as a forerunner of the ushering in of an administration pledged to the support of the American Merchant Marine—the third National Marine Exposition will mark the turning of the tide in things maritime. It will herald a new era—the placing of the American merchant marine in a position of stability, which will further its uphill fight for supremacy on the seas.

Wood Hulls Good Tankers

Satisfactory results have been returned by oil tankers converted from the hulls of the Ferris type steamers built during the war, according to a report received recently from the National Oil Transport Company. The operation of these wooden vessels as tankers is declared to be the first time that craft of wood construction have been used to carry fuel oil.

At present the company is operating a fleet of three of these vessels in the oil trade between Tampico and Galveston. Two other vessels of the same type are rapidly nearing completion for this service.

In addition to the operation of the oil tankers the National Oil Transport Company has signed charters for the operation of five cargo steamers in the Pacific Coast trade. The vessels are at present nearing completion in Seattle shipyards.

Steam Navigation Board to Meet

Capt. N. L. Cullin, secretary-treasurer of the National Board of Steam Navigation, has sent out notices announcing that the forty-ninth annual meetings of the Board will be held at the New Willard Hotel, Washington, D. C., December 7 and 8, at 10:30 A. M.

$36,500,000 CAPITAL IN SHIPPING COMPANIES FORMED IN OCTOBER

Only Ten Incorporations; Increase of One Over Previous Month, but Big Gain In Capitalization From a Year Ago

New shipping enterprises formed in October, with an authorized capital of $50,000 or more, numbered ten, their combined authorized capital being $36,500,000. This record shows an increase as compared with the organization in September of nine companies, involving only $6,720,000, and as compared with an indicated investment of $23,105,000 in October a year ago. The total is the largest reported for any month since June, according to the compilation specially maintained by the *Journal of Commerce.*

The indicated investment during the first ten months of the year appears as $562,423,000, a figure more than two-thirds greater than that in any year since the outbreak of the war in 1914. Returns for the entire twelve months of 1919 showed an aggregate of only $323,613,000, the previous top mark for the compilation. During January-October a year ago the combined authorized capital of the companies formed was almost exactly $300,000,000 below the showing for 1920 to date.

The indicated investment in new shipping enterprise during the periods named is shown in the following table:

August-December, 1914	$1,844,000
Year 1915	37,062,000
Year 1916	69,466,000
Year 1917	271,503,000
Year 1918	120,353,000
Year 1919—	
January	7,525,000
February	6,400,000
March	9,276,000
April	2,400,000
May	17,200,000
June	55,550,000
July	42,485,000
August	55,950,000
September	40,870,000
October	23,105,000
November	52,700,000
December	10,362,500
Total	$323,613,500
Year 1920—	
January	$76,305,000
February	33,380,000
March	61,850,000
April	178,835,000
May	31,083,000
June	86,050,000
July	26,250,000
August	24,550,000
September	6,720,000
October	36,500,000
Total ten months, 1920	$562,423,000

Five companies were organized during the month, with an authorized capital of $1,000,000 or greater, as follows: American Transatlantic Lloyd, Inc., $7,000,000; American Transportation & Trading Corporation, $20,000,000; American Siberian Corporation, $4,000,000; Brazadeno Company, $1,000,000, and Emerald Motor Ship Company, $3,000,000. Only three companies of such proportions were organized in the preceding month, seven were started in August, four in July, fifteen in June, fifteen in May, thirteen in April, twelve in March, seven in February and ten in January. During the first ten months of the current year, therefore, there were 87 shipping concerns chartered, with an authorized capital of $1,000,000 or greater.

The following list comprises the names, States of incorporation and authorized capital of shipping companies organized last month:

American Transatlantic Lloyd, Inc. Del.	100,000
American Shipping Agency, Del.	100,000
American Transportation & Trading Corporation, Del.	20,000,000
Ætna Steamship Corporation, N. Y.	100,000
American Siberian Corporation, Del.	4,000,000
Brazadeno Company, Del.	1,000,000
Black Star Steamship Company, N. J.	500,000
Dominican Steamship Company, Del.	300,000
Emerald Motor Ship Company, Del.	3,000,000
Mt. Washington Steamship Co., Del.	500,000
Total	$36,500,000

Old Cruisers Not Wanted

The old cruisers *Cincinnati* and *Raleigh* and the steamer *Supply* were ignored when bids were opened by the Shipping Board for a number of vessels, the highest offer being $42,000 for the gunboat *Castine,* made by the Inter-Colonial Steamship & Trading Company of New York. Only eight of the 30 vessels offered brought bids of any sort.

The *Castine* and *Petrel* brought an offer of $56,000 from R. Bruce Sommerville, of Pensacola, and for the *Petrel* alone Snare & Triest, of Washington, offered $25,000, while there was a bid of $35,000 for the gunboat *Machias* from Edward S. Hough, of San Francisco.

Bids for the steamships *Admiral II, Aileen, Cigarette* and *Naushon,* and the tug *James H. Clark,* ranged from $6,051 to $8,250, and, as in the case of the gunboats, were well above the minimum sale price set by the Government.

"Ker" Ships Names Changed

The American Ship & Commerce Navigation Corporation announces that it has adopted for the nomenclature of its present fleet and any future vessels it may own, names with the prefix "Mount." This affects the vessels of the Kerr Company's fleet, the names of which began with "Ker."

The eleven vessels at present owned by the company will have the following names: *Mount Clay, Mount Bliss, Mount Brace, Mount Bowdoin, Mount Seward, Mount Sheridan, Mount Sherman, Mount Sherrill, Mount Sidney, Mount Sterling* and *Mount Summit.*

The only name specifically applied to any vessel of the fleet at present affects the steamship *De Kalb,* which is undergoing reconditioning and fitting for third class passenger trade. The *De Kalb* is to be renamed the *Mount Clay.* New names for other vessels will be announced later.

MORSE CONCERNS FAIL

George W. Sterling Receiver for Eight Companies

The Atlantic-Adriatic Corporation, of which B. W. Morse, son of Charles W. Morse, is president, and seven subsidiary companies, representing seven steamships, passed into the hands of a receiver November 17, in an equity suit instituted by Marsh & McLennan, insurance brokers, whose claim amounts to $27,325.56 for advances made for insurance. The difficulties of the companies are laid to the lack of freight and the cut in transatlantic rates from about $19 a ton, required to meet the costs of operation, to about $16.

The indebtedness of the Atlantic-Adriatic Steamship Corporation is stated as being in excess of $1,500,000. Additional claims are estimated at more than $1,000,000. The total liabilities of the corporation are said to be more than $3,000,000, and it is alleged that the defendant companies have not sufficient funds to meet their indebtedness.

The petition does not give any figures explaining the corporation's assets, but mentions in this connection ships, cargoes, bills of lading, etc. A. G. Lampke, of Lampke & Stein, counsel for the corporation, said the litigation is of a friendly character, and that Federal Judge Mayer had appointed as receiver George W. Sterling, assistant director of operations of the United States Shipping Board.

NEW SHIPPING BOARD LIST

Rear Admiral Benson Remains as Chairman

Reappointment of Rear Admiral William S. Benson as chairman of the Shipping Board was announced November 13 at the White House. At the same time announcement was made of the appointment of six other members of the new Board authorized by the Merchant Marine Act. The other appointments are:

Frederick I. Thompson, Alabama, Democrat, term of five years; Joseph N. Teal, Oregon, Democrat, four years; John A. Donald, New York, Democrat, three years; Chester H. Rowell, California, Republican, two years; Guy D. Goff, Wisconsin, Republican, one year, and Charles Sutter, Missouri, Republican, one year.

Admiral Benson is appointed from Georgia as a Democrat, and his term is for six years. The appointments are recess ones, and the nominations under the law are subject to approval by the Senate.

To Discuss Motor Boats

The annual motor boat meeting of the Society of Automotive Engineers will be held at the Automobile Club of America, New York City, Tuesday evening, December 14, during the week of the National Motor Boat Show. The technical session will be preceded by an informal dinner, at which C. A. Criqui will be toastmaster, and the speakers will be prominent members of the motor boat industry.

BUSINESS NOTES

Albert H. Hopkins has resigned from the presidency of the Engineering Advertisers' Association of Chicago, and from the managership of the advertising and sales promotion departments of the C. F. Pease Company, Chicago, to become manager of the J. Roland Kay Company, international advertising agents, at their new building, 161 East Erie street, just east of North Michigan Boulevard, Chicago.

Mr. E. P. Williams, formerly with the McJunkin Advertising Agency, and later director of field work, Bureau of Market Analysis, Inc., has joined the staff of the Independent Pneumatic Tool Company, manufacturers of Thor air and electric tools. He will be located in the general offices, No. 600 West Jackson Boulevard, Chicago, and will have charge of the direct by mail advertising and sales promotion department.

Fairbanks, Morse & Company have purchased the entire business, consisting of all stock on hand, good will and liabilities of the Luster Machine Shop & Railway Equipment Company, 917 Arch street, Philadelphia, Pa. Fairbanks-Morse have opened a new branch at this address, under the management of Mr. D. W. Dunn, and will sell their complete line of engines, motors, pumps, etc. The entire personnel of the Luster Machinery Company has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

The International Western Electric Company has opened a new branch at 91 Rua Dos Ourives, Rio de Janeiro, Brazil. Mr. A. W. Burren, who will manage it, has spent the last two years traveling through Brazil familiarizing himself with the electrical requirements of his new territory. He has been associated with Western Electric interests for several years, and has been connected with its offices at New York, Antwerp, London, Buenos Aires and in Spain. Mr. Burren will be assisted at Rio de Janeiro by Mr. A. S. Santos, a sales engineer.

Mr. A. H. Ackerman, 427 Reaper Block, Chicago, has been appointed district sales representative of the Tacony Steel Company, Philadelphia, succeeding F. B. Hillwick. The Tacony offices have been removed from Marquette building to 427 Reaper block, Chicago.

The shipping, engineering and machinery exhibition, which was held at Olympia in the autumn of last year, was so successful that it has been decided to hold another upon similar lines at the same place September 7 to September 28, 1921. Plans and particulars can be obtained from Mr. F. W. Bridges, 36-38 Whitefriars street, London, E. C. 4.

J. J. Arnsfield, advertising manager of Fairbanks, Morse & Company, has been elected president of the Engineering Advertisers' Association of Chicago, vice A. H. Hopkins, who resigned his connection with the C. F. Pease Company to take charge of the domestic advertising division of the J. Roland Kay Company. Mr. Keith J. Evans, advertising manager of Jos. T. Ryerson & Son, was elected vice-president, and Julius Holl, advertising manager of Link-Belt Company, was elected a director to fill the vacancy made by Mr. Hopkins' retirement.

Charles H. Israel has been appointed Eastern representative of the Kingsford Foundry and Machine Works, Oswego, N. Y., for the sale of Kingsford stationary and marine unaflow engines. His New York office will be Room 1104 Equitable building, 120 Broadway, 'phone Rector 1845. The Philadelphia office is Room 722 Drexel building.

Mr. L. R. Fedler has been appointed district manager for the Keller Pneumatic Tool Company in the Milwaukee district, with offices at No. 915 Majestic building, Milwuakee. For the past twelve years Mr. Fedler has been associated with the sales organization of the Chicago Pneumatic Tool Company in the Milwaukee territory.

The Chicago Pneumatic Tool Company announces the removal of its rock drill plant from 864 East Seventy-second street, Cleveland, Ohio, to the Boyer pneumatic hammer plant at 1301 Second Boulevard, Detroit, Mich. The location of the company's Little Giant air drill plant at 1241 East Forty-ninth street, Cleveland, remains unchanged.

TRADE PUBLICATIONS

Marine Glue.—For all purposes where a waterproof glue is required, L. W. Ferdinand & Company, Boston, Mass., supply a special form of Jeffery marine glue. Instructions for the use of this glue are given in a pamphlet recently issued by this company.

Waterbury Rope.—A general catalogue, incorporating all the information about wire rope and cordage that the average user of rope would require, has been compiled by the Waterbury Company, New York City. This catalogue is arranged to quickly give the buyer the list prices and other essential data in connection with wire rope and fittings, armored wire rope, fibre-clad, and cordage.

Marine Hardware.—A catalogue covering the line of hardware produced by W. & J. Tiebout, New York City, is now being sent out. This catalogue gives special attention to marine, refrigerator and cabinet hardware, with specifications and prices for all material.

Marine Geared Turbines.—The General Elec- Company, Schenectady, N. Y., has sent out a catalogue describing the design and installation of geared turbine units developed for merchant vessels. No previous data in this form has been issued by the General Electric Company, so that the work will prove of great value to those interested in a study of turbines or who contemplate equipping vessels with this type of machinery. The general principles of design and construction of the Curtis type impulse turbine, as well as the double reduction gears built by the company are both given a general treatment in this book.

Froude Dynamometers.—Bulletin F-70 of the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., has been issued, describing the Froude type dynamometers for testing rotary prime movers of all types. Many illustrations showing dynamometers coupled to various types of engines are given in an attempt to show the various purposes to which Froude dynamometers are applicable. In addition to the general description, specifications for the dynamometers are also given.

NEW INCORPORATIONS

Ricameron Navigation Corp., Manhattan—Capital, $56,000; E. M. McBrearty, R. L. and E. L. Cameron, Bayside.

Haber Lighterage Co., Manhattan—Capital $40,000; F. J. McGeeney, A. J. and W. Haber, 11 Fourth Place, Brooklyn.

Erie Barge Freight Terminal Co., Buffalo—Capital, $100,000; S. J. Dark, W. O. Maltby, W. G. Gomez, Buffalo. (Erie Barge Terminal Co., dissolved.)

Baltic Shipping Co., Manhattan—Capital, $50,000; M. P. Breen, Jr., R. Mazzola, W. L. Carns, 128 Broadway.

Lamb & Ewart, steamship agencies, etc.—Capital, $55,000; F. R. Hansell, J. K. Vernon Pimm, E. M. Macfarland, Philadelphia.

Stern Shipping Corp., Manhattan, insurance and forwarding, $50,000; G. Henry, E. T. Stroud, S. Stern, 2 Stone St.

H. J. Wheeler Salvage Co., Brooklyn, vessels, $25,000; C. and H. C. Berlin, S. Gondelman, 858 Flushing Ave., Brooklyn.

Great Gulf Steamship Corp., $1,000,000; A. W. Britton, S. B. Howard, Robert K. Thistle, New York.

Globe Ship Repair & Marine Supply Company of New York, $200,000; Cornelius A. Cole, Hackensack, N. J.; Robert A. Van Voorhis, Jersey City, N. J.; William E. Schiels, Jr.; Brooklyn.

Diamond Steamship Laundry, Brooklyn, 5,000; J. E. and R. E. Stothard, N. Kaplan, 471 Eighth street, Brooklyn.

Oceanic Marine Supply Company, Manhattan, merchandise, $100,000; W. J. Baker, F. L. Savage, H. B. Walker, 320 West Eighty-sixth street.

Marine Protective Corporation, Manhattan, to protect property, 1,000 shares common stock, no par value; active capital, $5,000; W. F. Fennelly, F. X. Hennessey, W. Ingraham, 25 Broad street.

Overseas Forwarding Company, Manhattan, $20,000; J. R. Walker, S. H. Cone, E. J. Smith, 116 West Thirty-ninth street

Delaware & Atlantic Transportation Company, passengers; $500,000; James R. Cisco, Trenton, N. J.; John D. Hawkins, Arthur J. Kingsbury, Dover, Del.

Bowne-Mortons Stores, Brooklyn, wharfage and warehousing, $70,000; H. B. Gayley, H. J. Mayer, H. M. Samson, 149 Broadway.

Hebrew Transportation Corp., Brooklyn, steamship and railroad tickets; $25,000; C. E. Benoit, H. J. Greenstein, H. Johnson, 320 Broadway.

Richmond Terminal Warehouses, Richmond borough, $50,000; P. Meltzer, B. G. and L. P. Viguer, Tompkinsville.

Seven Seas Forwarding Co., Manhattan, $5,000; P. A. Pabistel, J. Mikifler, O. Tiedeberg, 188 Wadsworth Ave.

Ellsworth Express Company, Inc., Brooklyn, N. Y., $10,000; trucking, contracting, stevedoring; Edward N. Ellsworth, 387 Classon Ave.; Leslie H. Ellsworth, 95 Ryerson St.; Mortimer H. Michaels, 398 McDonough St., Brooklyn.

Roosevelt Steamship Co., build, own, operate boats, $1,000,000; Kermit Roosevelt, Oyster Bay, N. Y.; Russell Goldman, Max Zaliels, New York.

Pearce Transportation Corp., $100,000; C. T. Cohee, C. B. Outten, S. L Mackey, Wilmington.

General Welding and Engineering Corp., $100,000; Wray C. Arnold, Frank W. Fry, Frank A. Cabeen, Jr., Philadelphia.

Port Construction Co., Richmond Borough, $6,000; W. O. Coburn, M. Rosenholz, S. H. Schener, 9 University Place.

Mexican Dock Corp., Manhattan, real estate and mortgages, $500,000; F. and A. K. Kalb, J. G. Fenster, 206 Broadway.

Mitchell Ship Salvage Corp., raising sunken ships, etc.; $4,000,000; T. L. Croteau, M. A. Bruce, S. E. Dill, Wilmington.

Daly Towing Line, $15,000; M. M. Lucey, V. P. Lacey, L. S. Dorsey, Wilmington, Del.

Anchor Coal and Transit Line, boats, $50,000; F. H. Locks, George P. Bauersmith, J. H. Scott, Pittsburgh.

Great Gulf Steamship Corp., Manhattan, $1,000,000; A. W. Britton, S. B. Howard, Robert K. Thistle.

G. M. Luix Steamship Co., agents, $100,000; Antonio B. Camara, Oscar M. Malleeler, James J. Suludes, New York.

McCormack Stevedoring Co., Manhattan, $10,000; R. W. Burker, H. Hampel, T. F. Fay, 438 Third street, Brooklyn.

Archibald McNeil & Sons Co., of New York, Manhattan, coal, $2,000,000; M. J. H. E. Borchers, G. A. McLaughlin, 680 West End avenue.

Seacraft Corp. of California, Los Angeles, $250,000; E. A. Featherstone, Dustin Farnum, H. E. Roach, R. R. Thomas, Harry C. Keefe, J. A. Talbot and Marco H. Hellman.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Pacific Coast Steamer, Vancouver, B. C.—The keel for a large coastwise steamer to take the place of the Princess Sophia will be laid soon at the Wallace shipyards.

To Start Steamer, Bath, Me.—Preparations for laying the keel of the sister ship of the steamship A. L. Kent on the ways vacated at the Bath Iron Works by her recent launching are being made.

Would Buy Wooden Vessels.—The purchase of some of the wooden ships controlled by the Shipping Board, and which have been vainly offered for sale, is sought by citizens of a South American nation.

Tankers, Wilmington, Del.—The Bethlehem Shipbuilding Corporation, Ltd., has received a contract from the St. Clair Navigation Company for four tankers, two of 10,600 tons and two of 6,900 tons, to be built at their Harlan plant.

Buys Vessels from Navy, Tampa, Fla.—The Denton-Shore Lumber Company has purchased five additional vessels from the Navy Department, including a destroyer, a yacht, a minesweeper and two barges, at a cost of $200,000.

Recondition Steamer, New York.—The Amerika, former Hamburg-American Line steamer, has been turned over to the United States Mail Steamship Company by the Shipping Board, and plans are being prepared for her reconditioning.

To Build Small Vessels, Bagdad, Fla.—The Santa Rosa plant is likely to be reopened soon for the construction of small vessels. C. G. Mayo, of the Santa Rosa Sawmill Company, has been negotiating for the construction of seagoing barges.

Reconditioning Motorship, San Francisco, Cal.—A contract for reconditioning the motorship Annie Johnson, owned by the Matson Navigation Company, has been awarded to the United Engineering Company. The vessel will undergo extensive engine repairs.

Buys Schooners, Seattle, Wash.—Henry S. Seaborn, shipowner, has purchased three ocean sailing schooners, the Gamble, the Spokane and the Sophie Christenson, from the Fife Shipping Company, San Francisco, Cal. Mr. Seaborn's fleet now numbers six vessels.

Concrete River Steamers, New Bern, N. C.—Foundations have been laid for two concrete river steamers to be constructed by the Newport Shipbuilding Corporation. The work of forming and sheathing the vessels is well under way. Kirby Smith is superintendent.

New Munson Liner, Camden, N. J.—The keel for the new 6,000-ton passenger steamer which the New York Shipbuilding Corporation contracted to build for the Munson Steamship Line has been laid, and it is believed that she will be ready for operation late next spring.

To Rebuild Steamer, New York.—At an estimated cost of $1,600,000 the Mallory Line has decided to have the steamer San Jacinto rebuilt and converted into a first-class passenger ship for the coastwise trade, from plans being prepared by Theodore E. Ferris, 30 Church street.

Would Buy Wooden Motorships, Seattle, Wash.—One of the big marine corporations of the Pacific Coast, whose identity has not been disclosed, is negotiating for the purchase of the wooden motorships Donna Lane and Muriel, the last two cargo carriers built in Seattle this year.

Keel Laid for Cargo Ship, Tacoma, Wash.—The keel for the first private cargo ship to be built in Tacoma shipyards has been laid by the Todd Dry Dock & Construction Company. The vessel, which is to be a 6,500-ton, all-steel motorship, is being built for the Alaska Steamship Company.

Repairing Vessels, San Pedro, Cal.—The Los Angeles Shipbuilding and Dry Dock Company has been awarded the contract for repairs to the steamer West Eldara, damaged on a reef outside of Honolulu. One hundred and forty-nine plates must be replaced on the vessel. Repairs amount to $219,890.

To Complete Six Steamers, Mobile, Ala.—The launching of the 10,000-ton steamer Tuscaloosa City at the Chickasaw Shipbuilding and Car Company's yards a few days ago leaves six ships under construction at the yards, all of which are expected to be ready for commission during the coming year.

Passenger Liners, New York.—Theodore A. Ferris, 30 Church street, expects to complete the plans for two new passenger liners to be built for the Red D Line soon. These ships, which are to be about 400 feet long, are designed especially for service from New York to the north coast of South America.

Charleston Marine Activities.—The Western Wave, a Shipping Board steamer, is at the plant of the Charleston, S. C., Dry Dock & Machine Company undergoing general repairs. A new dredge, being built for work on Government projects at Savannah, is being pushed to completion by the company as fast as practicable.

Eight Motorships Bought, San Francisco, Cal.—The purchase of eight motorships by the Pacific Freight Corporation from the Australian Commonwealth is announced by W. L. Comyn & Company, general agents for the corporation. This gives the corporation the largest fleet of motorships flying the American flag on the Pacific.

To Have Electric Propulsion, San Francisco, Cal.—Steamers Archer and Invincible, which were built at the Union Iron Works and were originally equipped with geared turbine drive, are to be equipped with electrical propelling machinery at the Vulcan Iron Works, Jersey City, the General Electric Company supplying the machinery.

Steel Lighter, Fairfield, Md.—The first vessel built by the Globe Shipbuilding and Dry Dock Company has just been launched. It was built for the Ellicott Machine Company, is 150 feet long, 37 feet beam, 11 feet 6 inches deep, and is intended for harbor use. The next launching will be one of two 8,700-ton tankers for the American Fuel Company.

Capacity Production, Camden, N. J.—The New York Shipbuilding Company has as many orders on hand as it can handle for many months, and requiring the employment of 18,650 men. Seven passenger vessels will be built for the Shipping Board, four tankers for the Vacuum Oil Company and fifteen passenger and cargo vessels for various other interests.

Combination Tanker, Port Richmond, S. I., N. Y.—A combination molasses and oil tanker that the Staten Island Shipbuilding Company is building for the American Sugar Refining Company is scheduled for delivery next January. The contract was let last January, and the keel was laid five months after. The total cost will be a little less than $1,500,000.

Three-Masted Schooner, Machias, Me.—The three-masted schooner Netherton, measuring about 300 tons net, launched at the yard of the Job Shipbuilding Company has been sold to parties at St. Johns, N. F., and will be ready for sea in a few weeks. A duplicate vessel will be rushed to completion and launched in about six weeks from the same yard.

Cargo Steamers, Glasgow, Scotland.—The International Mercantile Marine Company, New York, has been advised of the launching of the Leyland Line cargo steamer Kakarian at the yards of David & William Henderson & Company, Ltd., Glasgow. This vessel is the first of six 7,300-ton sister ships under construction by the Hendersons.

Converting to Oil Tankers, Baltimore, Md.—The new steel freighter Vaba, built by the American International Shipbuilding Company at Hog Island, Pa., has arrived at Baltimore, Md., to be converted into bulk oil carrier for the Charbonneau-Rajola Company, of New York. The Vaba makes five Hog Island built freighters now at Baltimore to be converted into tankers.

Recondition Steamer, Quincy, Mass.—The ex-German steamer George Washington, which has been turned over to the United States Mail Steamship Company, has been sent to the Bethlehem Corporation's Fore River yard for repairs estimated to cost about $2,000,000; she is a steel, twin-screw ship of 25,570 gross tons, and was formerly owned by the North German Lloyd.

To Build for Mexico, Prince Rupert, Vancouver, B. C.—The Prince Rupert Dry Dock Company, Newman Erb, of New York, president, has a contract for the construction for Mexico of several steel revenue cutters, two cargo-carriers of about 1,000 tons each and a number of oil-tankers of from 7,500 to 10,000 tons each, the whole contract amounting to several millions of dollars.

Two-Class Passenger Liners, England.—Six of the new passenger liners to be constructed in the United Kingdom for the Cunard Line will be two-class passenger liners. The cabin rates on this type of ship will be much lower than those on the larger vessels. The first of these vessels, to be put on the American run on February 6, 1921, will be the Albania, making her maiden voyage.

Vessel Repair Contracts, Baltimore, Md.—The Shipping Board has awarded contracts for repairs to the Independence Bridge to the Marine Engineers' Corporation, the Capulin to the Curtis Bay Copper & Metal Works, the Western Comet to the Baltimore Dry Docks & Shipbuilding Company, and the Honadage to the Globe Shipbuilding Company, all of which yards are in Baltimore, Md., or vicinity.

Oil Tankers, Everett, Wash.—M. E. Barnham, receiver of the Norway Pacific Construction & Dry Dock Company, has a proposition from responsible oil interests which propose to build six steel tankers in the Everett yards of the company under the receivership, providing the creditors' consent has been secured and a court decree is made directing the receiver to enter into the contracts. The six tankers are to be of 12,000 deadweight tons with a capacity of 78,000 barrels each.

Reconditioning Liner, Quincy, Mass.—The Fore River Yard of the Bethlehem Shipbuilding Corporation has been awarded the contract for reconditioning the 17,000-ton liner Minnekahda, recently transferred from British to American registry, by the International Mercantile Marine Company. The work will cost

$1,000,000 and require three months for completion. When ready the vessel will be capable of transporting 2,150 third-class passengers. The other ships of the company will also be converted.

Reconditioning Steamer.—The United States Mail Steamship Company, of New York, will convert the Amphion and Freedom into passenger carriers, for which plans have been completed and contracts awarded. Plans and specifications conform to the highest requirements of the American Bureau of Shipping. The Amphion will have accommodations for cabin as well as 1,300 third-class passengers, and a cargo capacity of about 4,000 tons. The Freedom will carry 1,000 third-class passengers and about 3,500 tons of cargo.

Barkentines, Victoria, B. C.—Four four-masted barkentines, each of 2,500 tons, three of which are well under way, are being built at the Chilberg Shipyards, Ltd., to engage in the lumber trade, and will be capable of carrying 1,500,000 feet of lumber. The keel for the fourth vessel was laid late in November when the first of the barkentines was launched. These vessels are built on special design for the Victoria Shipyards, Ltd., a concern of British Columbia capitalists who have the backing of the Canadian government.

Idle Ships To Be Tankers, San Francisco, Cal.—D. W. Dickie, marine architect, will present plans to the Shipping Board for the converting of freighters now lying idle, and hulls that were built under war contracts and never completed, into oil carriers as a means for relieving the present shortage of tankers in the United States. The plans call for the installation of tanks in the freighters and refitting the crafts with Diesel electric engines in place of turbines. Conversion of the freighters into oil tankers would be undertaken at the time of the engine changes.

Tankers for Mexican Trade, Wilmington, Del.—The installation of a single-ended Scotch boiler ten minutes after the launching of the 10,000-ton tanker Eugene V. R. Thayer, for the Sinclair Navigation Company, and the placing into position of the others immediately after, is believed to be a record by the Harlan plant of the Bethlehem Shipbuilding Corporation. Work on three other tankers building at the Harlan plant for the Sinclair Company, and two building at the Fore River plant, is being expedited in an effort to fill the immediate need of the company for vessels in its Mexican petroleum oil trade.

To Build Eight Steamers, Chester, Pa.—The last of the government vessels building at the yard of the Merchant Shipping Corporation was launched recently, and the ways will be filled with private contract vessels for the following owners: Union Oil Company (Del.), two single-screw tankers, 10,000 deadweight tons each, triple-expansion vertical inverted cylinder reciprocating engines; Tide Water Oil Company, two tankers of same type and tonnage as Union Oil Company; Shawmut Steamship Company, two single-screw combination passenger and cargo boats, 10,500 deadweight tons each, Westinghouse cross-compound turbines with double reduction gears American Hawaiian Steamship Company, two twin-screw freighters, 11,000 deadweight tons each, Diesel engined.

To Install Engines, Port Richmond, S. I., N. Y.—The Staten Island Shipbuilding Company has secured several large jobs. One contract is for the installation of eight compound engines, 16 x 32 x 24 inches, in four ships of the Mexican Petroleum Company's fleet which were propelled formerly by electricity. The engines will be built by the Staten Island Shipbuilding Company. The first engine to be installed by February, 1921, and an installation to be effected monthly thereafter. Two new boilers are to go on one of these ships. The company is converting two bulk freight carriers, Twilight and Sunlight, belonging to the Standard Oil Company of New Jersey, by installing two longitudinal bulkheads and five athwart bulkheads in each ship. A total of about 250 tons of steel is required for each vessel.

SHIPYARDS AND DRY DOCKS

New Machine Shop, Beaumont, Tex.—The Beaumont Shipbuilding & Dry Dock Company plans a machine shop at a cost of $100,000.

New Yard Planned, New Bern, N. C.—The Newport Shipbuilding Company is planning the construction of a new shipyard at Wilmington, N. C.

Bond Issue of Shipbuilding Company, Los Angeles, Cal.—The Los Angeles Shipbuilding & Drydock Company has arranged for a bond issue of $1,250,000.

New Marine Works, Beaumont, Tex.—The Beaumont Marine Engineering Works has been incorporated, with a capital of $15,000, by J. C. Ellison, Roy Kellogg and John Currie.

Will Rebuild Shipyard, Tampa, Fla.—The Oscar Daniels Company plans to rebuild its shipyard and blacksmith shop recently burned. Loss estimated at from $20,000 to $25,000.

Shipbuilding Company To Be Dissolved, Vancouver, Wash.—The Great Northern Concrete Shipbuilding Company, which built five concrete ships during the war, has filed a petition for dissolution.

New Shipbuilding Company, Hoboken, N. J.—The Baltimore-New York Ship Service Corporation, 77 River street, was recently incorporated, with a capital stock of $500,000, to build ships, engines, etc.

Shipyard to Reopen, Slidell, La.—The plant of the Merrill-Stevens Shipbuilding Company will be reopened soon, according to S. Cuyler Jenkins and W. J. Payne, principal owners of the Louisiana plant.

Shipbuilding Plant for Sale, South San Francisco, Cal.—The Schaw-Batcher Company's shipbuilding plant has been placed on sale either as a whole or piecemeal. The plant has been designed for emergency fleet work, and cost $1,750,000.

Marine Railway, Etc., Wilmington, N. C.—A marine railway capable of accommodating vessels of 2,000 tons and 250 feet in length and costing $60,000 will be constructed by the Stone Towing Company. Machine and woodworking shops modernly equipped are also planned.

To Remodel Shipyard, New Equipment, Etc., Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation will remodel the former shipyard of the Terry & Brittain Company, recently acquired. Equipment will be provided for the construction and repair of all kinds of vessels. J. E. Merrill is vice-president and general manager.

New Shipbuilding Corporation, Jacksonville, Fla.—The Duval Corporation has been formed, with a capital of $400,000, by Eli Ness, M. A. O'Bryne and P. H. Haslam, all of Savannah, Ga., for the purpose of operating the 65-acre shipyard recently purchased by Mr. Ness from the Merrill-Stevens Shipbuilding Company as a steel shipbuilding plant.

Shipyard Leased, Wilmington, N. C.—The Liberty Shipyard has been turned over to the Newport Shipbuilding Corporation, under a five-year lease, and construction will be rushed on three concrete tankers and four river steamers. The company has secured contracts for two years, making necessary the employment of 500 men at an estimated pay-roll of $1,000,000 per year.

Marine Basin, Flushing Bay, N. Y.—The Robbins-Ripley Company, of Manhattan, has purchased about twelve acres of land, half of which is under water, near the Red Star Company's property, on Flushing Bay, where a marine basin wil be established by the construction of bulkheads and filling in. Plans are being developed and construction will begin early in the new year.

Canadian Yard to Resume Operation, Toronto, Canada.—The Dominion Shipbuilding Company's plant, which has been idle for several months, will be in operation soon, when the Henry Hope Company, of Peterboro, will complete the construction of two boats which the government had ordered some time ago. It is probable that more orders may be forthcoming and the plant kept running throughout the winter.

Shipbuilding Plant Sold, Mobile, Ala.—The shipbuilding plant formerly operated by the Fred T. Ley Company for the Shipping Board has been sold to H. A. Stone, of Philadelphia, Pa., for $141,600. This includes real estate, buildings, equipment, machinery and ship material with the exception of unused lumber. The plant has nearly a half mile of water frontage and good railroad connections.

Yard Without Future Plans, Newark, N. J.—The present programme of the Submarine Boat Corporation is nearly completed, and Henry Carse, president of the company, stated that no plans for the shipyard have been made. Some time ago it was reported that the company was planning to build large fabricated steel freighters equipped with Diesel engines. Nothing definite has been announced, however.

Building New Yord, Flushing Bay, N. Y.—The Red Star Towing Company, of Manhattan will have its new shipyards at Thirtenth street ready for business in a couple of months. The company is building two shipways for construction and repair work. The bulkhead was made by filling a dozen or so old scows with ashes and sinking them along about 600 feet of waterfront, the space back of the head being also filled in.

New Floating Drydock, Toronto, Can.—A floating drydock 300 feet in length and costing between $75,000 and $80,000 is now being constructed at Ashbridge's Bay to accommodate the largest freighters on the Great Lakes. The dock was built in Montreal for the John E. Russell Shipbuilding Company, Toronto, and the sections are being towed from Montreal. This dock will save vessels being sent to Collingwood or Kingston for repairs.

New Shipbuilding and Repair Plant, Gloucester, N. J.—John Meigs, Philadelphia, Pa., former assistant director of the local department of wharves and docks, and associates have organized a company to establish a ship construction and repair plant in the vicinity of Gloucester, N. J., and have secured options on a site on the Delaware River near the Reading ferry. Plans are being prepared for shops, and large floating drydock. R. E. Havens, 507 Federal street, Camden, N. J., is engineer.

Dry Dock, Esquimalt, B. C.—The Dominion Public Works Department, Ottawa, Canada, will receive bids until December 9 for the construction of a drydock in Skinner Cove a short distance from the present government dock. The dock will have a length from outer caisson stop to head wall of 1,150 feet, width of entrance 125 feet on sill, and 135 feet at coping level; depth on sill at ordinary high water spring tides, 40 feet. The dock will have two inner sills located 400 and 750 feet from the entrance sill, respectively. Two floating caissons will be provided for closing outer and inner entrances.

Floating Shipyard, New York.—A new ship repair plant, which will operate in New York, is being completed by the Globe Ship Repair & Marine Supply Company. Captain C. A. Massey is president of the new concern, and James McKeller, vice-president and general manager. This plant will be especially designed to expedite repairs on steamers above the water line. The plant is on a boat and can go alongside of a vessel at short notice, and do all necessary repairing while the vessel is in the stream or at the dock. It will be able to make all kinds of engine and boiler repairs, electric and acetylene welding and cutting, pipe fitting and plumbing, repairs to hull, painting and scraping; in fact, everything required except drydocking.

PORT IMPROVEMENTS

Sea Wall, Port Lavaca, Tex.—The city has voted bonds for $120,000 to cover cost of constructing a sea wall. Address D. E. Guidry, Mayor.

Water Front Improvements, Aransas Pass, Tex.—The city will vote on $225,000 bonds to improve the water front. R. Savage, Corpus Christi, Tex., attorney.

New Piers, New York.—A couple of good-sized piers are to be erected on the site of the old Williamsburgh ferry house at Roosevelt street and the East River.

Terminal and Freight Warehouse, New Bern, N. C.—A terminal and freight warehouse are to be built for the new Federal Boat Line connecting New Bern with Baltimore and northern points.

Seawall, Bay St. Louis, Miss.—Gulfport, Miss., city commissioners plan to construct a seawall at Bay St. Louis, along the city front; reinforced concrete construction. H. D. Shaw is engineer.

Quays, Rio de Janeiro, Brazil.—The Company of the Port has addressed a petition to the Government demanding the construction of new quays, made necessary by the steady increase in the traffic at the port.

Dock Equipment, Portsmouth, Va.—The City Council plans an appropriation of $3,500,000 for freight handling machinery, conveying and loading machinery, cranes, etc., to be installed on the city's new municipal docks.

Wharf, Thetis Island, B. C.—The Department of Public Works, Ottawa, Canada, let contract for building a wharf at Thetis Island to the Vancouver Pile Driving & Contracting Company, 207 Hastings street, W. Vancouver, B. C.; about $64,000.

Electric Dredge, Gray's Harbor, Wash.—Provisional plans are being drawn by C. A. Strong, port engineer, for the construction of a $250,000 dredge for port development work. The dredge will be of 22-inch section type and operated by electricity.

Dredging, Seattle, Wash.—The Board of Public Works will soon receive bids for dredging east slip of Pier A, Smith's Cove, for filling Elliott avenue, involving 200,000 cubic yards dry earth excavation. A. H. Dimock, Seattle, is engineer.

Grain Elevator, Brooklyn, N. Y.—Building of a 1,250,000 bushel grain elevator by the state has been begun at the foot of Columbia street, and it is expected that a total capacity of 20,000,000 bushels will be provided to take care of shipments from lakes by way of the State Barge Canal.

New Wharf, New Orleans, La.—W. O. Hudson, president of the New Orleans Dock Board, has completed negotiations with the War Department for 1,200 feet of wharf space at the Army Supply Base for a new wharf. He also bought a submarine chaser to be used as a fireboat, from the Navy Department.

Dredging, New York.—Murray Hulbert, Commissioner of Docks, Pier A, North River, New York, has let contract for dredging piers at Stanton street, East Fifth, East Twentieth, East Second and West Thirty-fifth streets to the Morris & Cummings Dredging Company, 17 State street, New York; $111,685.

Piers, Oswego, N. Y.—E. S. Walsh, superintendent of Public Works, Albany, N. Y., let contract for building concrete foundation piers for the proposed grain elevator on Barge Canal Terminal pier (Terminal Contract 80), to the Brown & Lowe Company, and Law Brothers, Foster avenue, Schenectady; about $336,412.

Dredging, Etc., Fort Worth, Tex.—The city plans to dredge the Trinity River from Paddock Viaduct to a point near Lake Worth, and also dig a canal to connect with the lake. Plans also include two locks and dams to permit boats to run from Fort Worth to the lake; about $250,000. W. D. Davis, mayor.

Barge Canal Terminal, Gowanus Bay, N. Y.—Ground for the new State Barge Canal terminal on Gowanus Bay, to cost about $428,000, was broken about the middle of November, and the work will be rushed ahead as fast as possible. The concrete work of the southern half of the stock is to be completed by July 1, 1921.

New Dock, Savannah, Ga.—The Savannah Coal & Dock Company, recently organized, has taken over the river frontage formerly occupied by the Foundation Company as a shipyard for a ship coaling station. Contract for a new dock and other features of the enterprise has been let to the A. Bentley & Sons Company, Toledo, Ohio.

Pier, Toronto, Canada.—The Department of Public Works, Western Block, Ottawa, Canada, let contract for building 466 feet of superstructure of east pier at eastern channel of Toronto harbor, involving 2,000 cubic yards reinforced concrete, to S. Boone Dredging & Construction Company, Ltd., Excelsior Life Building; $68,679.

Wharves, Docks, Piers, Etc., Baltimore, Md.—The city has voted on a $2,500,000 loan for extensive harbor improvements, including the acquisition of sites on which the city intends to construct wharves, docks, piers, bridges, etc.; $10,000,000 was also voted for the development and extension of the harbor. W. F. Broening, president Board of Awards.

Terminal Contract Awarded, Havana, Cuba.—The firm of Snare & Trieste, New York, has been awarded the contract for building the Ward Line's new terminal at Havana. This is largely a bulkhead proposition and will be equipped with the most modern and improved freight-handling machinery. The project will require about two years for completon.

Piles, Bulkhead, Etc., Brooklyn, N. Y.—Contract T-79, E. S. Walsh, Superintendent of Public Works, Capitol, Albany, N. Y., has let contract for driving foundation piles for proposed grain elevator, building concrete bulkhead wall on Henry street, and dredging Henry Street Basin, Gowanus Bay, to Raymond Concrete Pile Company, 90 West street, New York City, $428,259.

New Jersey Canal.—Colonel J. C. Sanford, of the Army Engineers, will make a report to the Government on the proposed 33-mile canal tapping the Delaware River near Bordentown, south of Trenton, N. J., and connecting with Raritan Bay near South Amboy, which will give New York, Baltimore and Philadelphia, as well as other cities along the canal, through inland waterway connection.

Wharves, Warehouses, Etc., Argentine, S. A.—Extensive port improvements are being undertaken by the Government of Argentine. Work has begun on improving the port at Commodore Rivadavia the outlet for the oil fields. Wharves and warehouses are to be built at a cost of $1,700,000. At Rosario the Government expects to spend $3,000,000 for increasing the dockage and warehouse facilities.

Dredging, Philadelphia.—The Canal Construction Company, Philadelphia, Pa., has been awarded a contract for the restoration of the 12-foot channel between Philadelphia and Trenton. The work of removing rock and recently formed shoals and otherwise improving the channel will be under the direction of Colonel Ladue, United States engineer; $55,000 has been appropriated for the work.

$6,000,000 Ocean Terminal, Seattle, Wash.—Construction of a $6,000,000 ocean terminal for the Pacific Steamship Company on the twenty-six-acre site of the former Skinner & Eddy yard has been taken under consideration by the Shipping Board, the completed terminal to be bought by the steamship company. Plans call for three 1,000-foot piers with berthage for twelve ocean ships at a time, and a five-story steel and concrete warhouse and office building; the pier, transit sheds and warehouse to have a cargo capacity of more than 325,000 tons, and to be equipped to handle millions of tons of freight each year.

$100,000,000 Port Project, New York.—Alton H. Greeley, of Cleveland, Ohio, president of the American Chain of Warehouses, has again presented to a special sub-committee of the Board of Estimate of New York City a plan for the expenditure of $100,000,000 private capital on the development of 1,000 acres of city-owned land north of Barren Island and east of Flatbush avenue. The programme includes the construction of a 5,000-foot bulkhead, six 1,000-foot piers, warehouses, streets and industrial plants at an expense of $14,000,000. The project is contingent upon the United States Government dredging the channel to a depth of 30 feet.

New Docks, Dredging, Etc., Melbourne, Australia.—The Port of Melbourne Authority, the Harbor Trust Commissioners, have prepared a scheme for the construction of a series of new river docks on the north of the Yarra, westerly from the Victoria Dock, which provides for four docks covering 800 acres, costing approximately $24,355,072. The first dock to be built will provide 20 additional berths, and will have a total area of 86.61 acres, giving a berthage space of 11,400 feet. The cost of this dock is estimated at $5,307,684. Of the four docks provided for, three are to be served by one entrance 250 feet wide, at the junction of the Yarra and Maribrynong rivers. The remaining dock will be served by a separate entrance 200 feet wide. The general depth of the water is to be 32 feet. The Maribrynong River is to be widened to 300 feet and deepened to 27 feet for some distance beyond the junction with the Yarra.

SHIPPING DEVELOPMENTS

Transportation Company, Baltimore, Md.—The Covington Maritime Corporation, 111 N. Charles street, was organized by Wynn L. Van Schaick, John B. Johnson and George R. Gaither.

New Steamship Line, New London, Conn.—Plans have been completed for a new coastwise service between New London, Conn., and Norfolk, Va., by the Manufacturers' Association of Connecticut.

Steamship Company Organized, Baltimore, Md.—The Bella Steamship Company, 803 Calvert Yuilding, has been incorporated, with a capital of $250,000, by Antonio T. Carrozza, John H. Leonard and Edwin H. Brownley.

New Steamer Sold, New York.—The new 9,400 deadweight ton steel merchant vessel Charles M. Cramp has been sold to the Atlantic, Gulf & Pacific Steamship Company, 13 Park Row, for $1,739,900 by the Shipping Board.

New Shipping Firm, Boston, Mass.—The Keans Transportation Company, Inc., 114 State street, has been incorporated by Guy L. Keans to manage sailing vessels. The company now has four schooners in service and has plans for expansion.

New Steamship Company, New York.—The Polish Navigation Company, Inc., was recently incorporated, with a capital of $3,000,000, and is planning the purchase of a ship for establishing service between New York and Danzig. K. S. Pomierski, 1777 Broadway, is vice-president and secretary of the company.

Pensacola-Cuba Service, Pensacola, Fla.—A new steamship line between Pensacola and Matanzas, Cuba, will be established by the Gulf, Florida & Alabama Railroad, according to H. W. Stigler, agent for the line in Memphis. The first vessel will sail from Pensacola soon, and freight will be accepted for all points in Cuba, including Havana.

First "535" Ship Nearly Ready, New York.—The steamer Wenatchee, first of the new "535" vessels to be commissioned by the Shipping Board, will be turned over to the Pacific Steamship Company, December 31, at New York, and is to be placed in the transpacific service. Several similar steamers are to be allocated to the Pacific Mail Steamship Company.

Buys Old Dominion Steamers, Norfolk, Va.—The Old Dominion Transportation Company recently organized to take care of the truck shipments to the north, has bought the steamers Hamilton and Jefferson from the Old Dominion Steamship Company for $850,000, and has taken over the Norfolk terminals of the steamship company.

Winter Sailings from Portland, Me.—The first sailing from Portland on the Anchor-Donaldson Line service between Portland and Glasgow during the winter will be the steamer Saturnia, sailing on December 9, it being a Christmas sailing. Other sailings will be the steamer Cassandra, on December 30, February 18 and March 30, and the Saturnia, on January 18, March 11 and April 30.

American Vessels and Oriental Trade.—It is reported by the Manila agency of the Osaka Shosen Kaisha that vessels of the United States Shipping Board have finally been admitted into what is known in the Orient as the China Homeward Conference, a concession which, if confirmed, will grant vessels flying the American flag the privileges enjoyed by other vessels plying in the China trade.

Lake Ship Line Control Sold, Benton Harbor, Mich.—It is announced by J. H. Morton, president and general manager of the Graham & Morton Transportation Company, operating steamers on Lake Michigan between Chicago, Benton Harbor and Holland, Mich., that the controlling interest of the company has been sold to Nathaniel Robbins, of Grand Haven, Mich. Mr. Morton will continue as general manager.

Intercoastal Trade Plans.—Nine companies have entered or announced their intention of entering the intercoastal trade between the Atlantic and Pacific. They include the Pacific Mail, Luckenbach Lines, United American Lines (Williams, Diamond & Co.), Isthmian Lines, Robert Dollar Company, Admiral Line, Sudden & Christensen, Atlantic, Gulf & Pacific Steamship Corporation and Matson Navigation Company.

Ex-German Steamer Bought, New York.—The International Mercantile Marine Company has bought the 17,324-ton German steamship Berlin from the British Government, and is in the market for others of the German ships now for sale in England, with which to build up the White Star fleet to its pre-war strength. The Berlin is 590 feet long, 69 feet wide and 38 feet depth of hold, has reciprocating engines and a speed of 18 knots.

Coast to Coast Service, Newark, N. J.—The Transmarine Corporation coast to coast service via the Panama Canal will be opened with the sailing of the steamer Surichco from Port Newark, N. J., to San Pedro, San Francisco and Portland. The vessel will also accept traffic for Hoquiam and Aberdeen, Wash. The Transmarine Corporation is a subsidiary of the Submarine Boat Corporation, 5 Nassau street, New Cork.

New Steamship Corporation, New York.—The Roosevelt Steamship Corporation has been incorporated under the laws of Delaware, with a capital of $1,000,000, by Kermit Roosevelt, former vice-president of the Kerr Steamship Company, Russell Goldman and Max Zaliels, all of New York. The company has purchased the harbor tug Kermit from the American Ship & Commerce Corporation and intends to go in for allocations of Shipping Board vessels in worldwide trade.

Steamers for West Indies, New York.—The International Maritime Lines, of No. 44 Whitehall street, are planning to place all their Lake type steamers in West Indies business and to put four 7,300 tonners of the Hog Island type or 8,800 tonners in Scandinavian business. In connection with this development a new corporation to be capitalized at several millions is to be created. The corporation has been sending vessels to Scandinavia for nearly two years. E. V. Culberson is treasurer.

Electric Passenger Ship, Brooklyn, N. Y.—The Cuba, a 300-foot steamer and the first passenger vessel to be fitted out with an electric drive, passed her dock trials at the yard of the Morse Dry Dock and Repair Company, and has been placed in commission in the Jacksonville-Havana run. The Cuba was formerly the Powhatan. She was reclaimed after being sunk in Chesapeake Bay and virtually rebuilt. The Cuba is electrically driven, electrically lighted and her winches are electrically operated.

New Steamship Company, Philadelphia, Pa.—The Pennsylvania Trans-Atlantic Steamship Company is being organized, with a capital of $1,000,000, to transact a general shipping business and to own and operate vessels from Philadelphia to all parts of the world. The new company proposed to purchase from the Government, on the deferred payment plan, ten ships with a capacity of 60,000 tons. It is claimed that the company has contracts in hand for the movement of coal from the Atlantic range to French Atlantic ports.

To Operate Refrigerator Steamers, New York.—The five Shipping Board refrigerator steamers which were surrendered by operators whose time charters had expired will be continued by the International Freighting Corporation, 170 Broadway, and will run from Philadelphia to the River Plate and thence to Liverpool, Antwerp and Rotterdam, returning to Philadelphia. The fleet includes the steamships Monasses, Oskawa, Yauhill and Guimba. Two of these are now being operated by the Elder Steel Steamship Company, whose charters will expire on January 1, and they will at once be transferred to the International Freighting Corporation.

Round the World Service, Portland, Ore.—A new round-the-world service from Portland, with San Francisco as a port of call, is to be established by Gerritsen, Curtis & Co., under the name of the Curtis Line, according to Clifton Curtis Jr., vice-president and general manager. The line will operate chartered steamers. It will proceed eastward or counterwise to the Pacific Mail 'round-the-world service. Leaving Pacific Coast ports, the vessels will go to the United Kingdam, Antwerp, Rotterdam, Stockholm and other northern European ports, thence to Marseilles, Mediterranean ports, the Suez Canal, Dutch East India, Manila, Saigon, Hong Kong and other Far East ports, and return to the United States Pacific harbors.

GOVERNMENT WORK

Steam Locomotive Jib Crane, South Boston, Mass.—Specification 4263, Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids on a 50-ton steam locomotive jib crane.

Lighthouse, Bowler's Rock, Va.—The Superintendent of Lighthouses let contract for building a lighthouse to the Raymond Construction Pile Company, Munsey Building, Baltimore, Md., $18,000.

Dredging, Stamford, Conn.—The United States Engineer let contract for dredging in Stamford and Norwalk harbors to J. S. Packard Dredging Company, 1004 Turks Head Building, Providence, R. I.; $107,000.

Building and Improvements, Quantico, Va.—Specification 4334, Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensive improvements and construction of buildings (large contract).

Dredging, Galveston, Tex.—United States Engineer, War Department, Washington, D. C., let contract for redredging part of the waterway from Galveston to Corpus Christi, Tex., to J. Jacobson, Galveston, Tex., $4,000.

Machine Shop, Etc.—Bureau of Yards and Docks, Navy Department, Washington, D. C., has completed plans for a new one-story machine shop and testing works for the Navy Department, 82 x 300 feet; one-story foundry, 60 x 100 feet, and power plant, 70 x 81 feet.

Piers and Dredging, Newport, R. I.—Specification 4090, Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract for building a new pier, extending two piers and dredging at Goat Island, to Booth & Chase Company, Inc., 29 Bedford street, Fall River, Mass., $71,967, 210 days.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
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Vice-President—E. H. Monroe, 902 Virginia Ave., Washington, D. C.
Secretary—B. G. Barnes, 970 High St., Bath, Maine.
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CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
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Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottetown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Canada.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

ITALY

COLLEGIO DEGLI INGEGNERI NAVAL E MECCANICI IN ITALIA,
Via Carlo Alberto 18, Genova.

TRADE PUBLICATIONS

Brownhoist Locomotive Cranes are described and illustrated in Catalogue K-1919, published by The Brown Hoisting Machinery Company, Cleveland, Ohio. The introduction to this catalogue is as follows: "The locomotive crane has become a necessity in railroad, shipbuilding, contracting, steel, coal, lumber, shipping, mining, foundry and manufacturing industries. It is a necessity in any business where there is enough material to be handled to warrant the expenditure. It is a tool that works day and night, and it does this work at a much less cost than when hand labor is used. The daily cost of a Brownhoist locomotive crane under normal conditions is approximately $10, which includes depreciation, 6 percent interest on the investment, and all operating costs. This is figured with the crane working ten hours a day for three hundred days in the year, and if the crane is worked more than this the daily cost will be reduced. This crane does the work of a number of men, in some kinds of work replacing as many as forty to fifty laborers. Its value to the railroad contractor, manufacturer, and steel, coal, lumber, shipbuilding, shipping, mining and various other industries is illustrated on the following pages. This catalogue illustrates the standard types of Brownhoist locomotive cranes and the different operations, showing how and where some of the cranes are used. Brownhoist locomotive cranes have been used for over a quarter of a century, and to-day these cranes are found in all parts of the world. Their records prove them to be safe, speedy and durable. Many Brownhoist cranes have been in continuous service for twenty and twenty-five years and even longer, and they are still at work. It requires a good crane to do this."

"Sargent Marine Hardware" is the title of a catalogue published by Sargent & Company, New Haven, Conn. The book deals particularly with hardware that is used for cabin and saloon fittings, such as knobs, locks, hook, window fastenings, grab rails, locker fittings, bolts, sash balance, pulleys, telegraph hooks, etc.

The Electric Rivet Heating Forge manufactured by The United States Electric Company, New London, Conn., is described as follows in a circular the company has recently issued: "This forge was designed and built to meet the requirements of shipbuilders, structural steel builders and boiler manufacturers, and wherever it is necessary to use hot rivets from ¾ inch to 1¼ inches diameter, 3-inch shank; the time for heating being from seven to fifteen seconds, and at a very low cost. The electrodes are arranged to heat two rivets at one time, delivering four 1-inch rivets per minute, which is as fast as they are required. The rivets are brought to the proper heat entirely free from scale, and are passed on to the riveter. The pan of the forge is designed to hold a keg of rivets in front of the operator or heater, and the rivets are easily placed by hand in the electrodes and removed with the tongs when heated. This operation is very simple, the conductor being operated either by foot or hand lever, bringing the electrode in contact with the point of the rivet or rivets to be heated, pressing down on the lever, and, when the desired heat is reached, the conductor goes back by removing the pressure on the lever. This method of heating rivets eliminates the following: Loss of time in starting forges in the morning and at noon time; loss of burned rivets; breaking and carrying of coke and fuel for forges; air hose and air where same is used to blow up the fires, fittings, etc. Smoke and gases in close compartments on ships, boilers, etc. The forge is supplied at a small additional cost, with a set of electrodes and 20-foot leads covering a surface of 20 feet, which can be used in heating loose rivets or rivets that have not been driven solid, reheating the rivets in the plate or structural part without removing them and driving them up tight."

Electric Traveling Cranes, Portable Electric Hoists, Standard Monorail Hoists and Trolleys are among the various types of apparatus described in a catalogue published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. The introduction to this catalogue is as follows: "In most lines of manufacturing some of the various forms of power cranes or hoists are now a necessary feature of the equipment employed. Nearly every step in the various processes is so dependent upon the hoisting apparatus as to be at least seriously crippled in case, as sometimes happens, this is temporarily not in operative condition. Cranes are necessarily located in an unfavorable position for cleanliness, or supervision by responsible persons. Their design should, therefore, have special reference to these unfavorable conditions. It may be safely stated that insufficient lubrication, an accumulation of foreign matter in the working parts and rapid destruction of bearings, gear teeth, etc., due to defective alignment of related parts, is responsible for most of the difficulties experienced. We believe that Shepard cranes and hoists are the only ones yet constructed which will maintain all the running parts in corect alignments, and thus keep the pressures and stresses in gear teeth, bearings, brakes, etc., within safe limits, and which have all working parts fully enclosed and a system of lubrication sufficiently simple and positive to insure economical and reliable service with ordinary care. While we manufacture cranes in all sizes ordinarily employed, attention is particularly invited to these machines in the small capacities; they are not, as is usual, improvised and adapted from other standard parts, but each of the small-size machines is a duplication."

Grey Iron Ship Castings are described in Catalogue A., published by The Central Foundry Company, 90 West Street, New York. "The constant changes being made in ship construction and the lack of standardization have created a demand for many and varied ship castings. In this catalogue we have included for your convenience those castings which were used most extensively during the past year. The ample facilities for our foundries have enabled us to meet the most exacting requirements of many of the largest shipbuilders and also to keep pace with the changes made. The utmost satisfaction has been given by our castings in service ranging from the Panama Canal to U. S. Navy barges, and we are fully experienced and equipped to make general castings of every description to your own specifications and blue prints. We desire at all times to co-operate in fulfilling your requirements and we solicit your inquiries. As newly designed castings are made we shall forward full information in the form of pages to be inserted in this catalogue. All weights mentioned herein are subject to variation of 5 percent."

"Aeroil" Thawing Outfits and Torches are described by the Aeroil Burner Company, 400 Main street, Union Hill, N. J., in a bulletin recently issued. One type is described as follows: "This outfit is equipped with two torches so that two men can each operate a torch from the same tank. Recommended for large coal yards, naval, marine, tidewater and railroad coaling stations for quickly opening frozen loading gates. Also used by railroads for thawing out switches at terminals and other important switch points where delays are costly and speed is essential."

W-S-M Dock Cranes at the U. S. Army Supply Base, Boston, Mass., are the subject of Bulletin No. 28, published this month by the Wellman-Seaver-Morgan Company, Cleveland, Ohio. "The Wellman-Seaver-Morgan Company has recently installed four semi-portal bridge type cranes at the U. S. Army Supply Base, Boston, to handle freight to and from ships. The Boston Terminal includes a long eight-story warehouse, separated by a wide roadway from the marginal two-story shed on the wharf alongside which the ships dock. Between the wharf shed and the water is a space 35 feet wide carrying two railroad tracks on which freight cars are run in from main line tracks to deliver or receive freight from the boats. The W-S-M cranes span these tracks and handle the freight between either story of the shed and the boats, and do other general service as well."

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CHICAGO

"The Trackless Train."—The Mercury Manufacturing Company, 4118 South Halsted street, Chicago, Ill., in a booklet recently published, shows many photographs of typical Mercury installations of their industrial haulage system. "A fresh idea broad enough to affect the industrial world is a rare thing, but it stands out from others in direct proportion to its rarity. Watt's steam engine, Whitney's cotton gin, Arkwright's loom, all stand out because they embodied the new idea of freeing human hands from purely mechanical toil. Without presumption it is possible to place Mercury methods in the same category with these revolutionary industrial devices because Mercury frees human hands and releases men from acting as beasts of burden. Mercury methods are an outgrowth of original research into material-handling methods. The Mercury tractor was built to fit the Mercury system of internal transportation, and is, therefore, the means of accomplishing the results attained through 'The Trackless Train.' A quotation from the earlier literature issued by the Mercury Manufacturing Company may help to explain this statement: 'While industrial production was modernized and increased by methods of efficiency, the methods of handling materials within industries were standing still. Equipment for handling materials was occasionally changed, but the method remained the same. After months spent in surveys and in building a system, the tractor-trailer method was evolved, and the equipment was then constructed to fit the method.' This, in brief, is the story of a method which is bringing to industry an improvement hardly less vital than that accomplished by the steam engine. The application to industry is so general, moreover, that its effect is apt to be economic as well as industrial."

"Monel Metal" is the title of a pamphlet published by the Bayonne Casting Company, Bayonne, N. J. The introduction states: "It is truly said that industry never creates a demand that the engineer or metallurgist does not meet. Copper and bronze alloys served most purposes satisfactorily so long as they were only required to withstand alkaline or acid solutions. With the growth of industry new conditions have arisen which call for metals possessing unusual qualities. There is a broad field for an alloy which will withstand acids, high temperatures and the erosive action of hot gases and superheated steam. Monel Metal, highly non-corrodible and with the strength of steel, meets these severe requirements. Monel Metal was first made ten years ago, and the demand for it has grown so rapidly as the knowledge of its characteristics could be spread. In the early stages of development, Monel Metal was supplied only for its high tensile strength and relative immunity to corrosion, while at the present time Monel Metal has many diversified uses. It is the endeavor of The Bayonne Casting Company, in issuing this pamphlet, to direct attention to the physical properties of Monel Metal, the forms in which it is sold and its general uses. It is our further purpose to co-operate in every way with the users of Monel Metal in order to insure its satisfactory application and service. Some of the methods of treatment are not very generally understood, and it is our desire that any consumer wishing technical advice or information will communicate with us."

"What is a Shop?" is the title of a circular published by the engineering and construction firm of Westinghouse, Church, Kerr & Company, Inc., 37 Wall Street, New York. In this circular the company defines the shop as follows: "A shop is primarily a layout of equipment housed in a suitable building—not a ready-made, stock design structure into which equipment has somehow been fitted. In the design and construction of any shop we first make an ideal equipment layout, co-operating with the client in working out routing and handling problems. We then design and build the buildings over and around the equipment, suiting the building to the conditions which the layout imposes. The ideal layout means routing and handling economies and reduced production costs. The buildings are designed and constructed to reduce overhead by being low in first cost and economical to maintain. This W. C. K. method of meeting specific requirements by building over and around a layout is fundamental with us on whatever work we are engaged."

"Thor Super-Power Electric Drills" is the title of a circular published by the Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, Ill. Thor points of superiority are claimed as follows: "The internal gear drive permits the use of smaller gears and gear case—three teeth in contact instead of one. Small and compact due to the distributed pole motor construction and small gear case. The method of winding the field and armature and the use of ball and roller bearings result in greater power. Extreme durability; interlocking commutator bars; fully taped and insulated coils; large brushes, and perfect automatic brush holders insure long life. Highest efficiency results from the unique motor construction and elimination of all friction. The Thor switch breaks both sides of the line, leaving no current in the drill when idle. It would be impossible to make a switch insuring greater safety. These features are used in Thor electric tools exclusively, and will not be found in any other make. Their compact construction, neat design and high-grade finish are unsurpassed. A Thor electric will drill a hole in metal or wood in one-fifth of the time required by hand. Easy to handle and operate. It will pay for itself in 30 days. No shop can afford to be without one or more of these tools."

You Always Know that the contents of each Linde Oxygen cylinder is up to the Linde standard of purity, according to a statement made in a circular issued by The Linde Air Products Company, 30 East Forty-second street, New York. "By means of careful checking every few minutes during production the purity of Linde Oxygen is kept not only high, but uniformly so. Any production below the Linde standard of purity is discharged into the air. Hence Linde Oxygen is depended upon by thousands of users to produce satisfactory results with the highest economy. The expense of this extreme refinement is spread over such a large volume that no individual user bears a discernible portion of it. Whether for one cylinder or 1,000 we'll fill your orders immediately—there are 65 Linde distributing stations covering the United States."

Marine Lighting and Signaling Apparatus is described in a catalogue published by the Benjamin Electric Manufacturing Company, Chicago, Ill. "For those who go down to the sea in ships and those who send the ships to sea there's a close community of interest in Benjamin marine lighting and signaling apparatus. Trim in appearance. Sturdy in construction. Durable and seaworthy over long periods and severe conditions of service. In every line and detail, made with a fine knowledge of requirements and a high regard for the conditions to be fulfilled in modern ship equipment. Junction boxes, receptacles, connecting blocks, switches, covers and fittings are interchangeable."

Superheat and Lubrication is described in bulletins issued by the Locomotive Superheater Company, 30 Church street, New York. "Valves and cylinders must be lubricated. Lubrication is accomplished either by water in the steam, accompanied by heavy and frequent rod swabbing, or by direct oil delivery. Conditions requiring lubrication are a proof of superheat conditions. There is no moisture in superheated steam; therefore, direct oil lubrication is necessary. If it is not necessary, then superheated steam is not being delivered to the cylinders. Fire-tube superheaters are supplying superheated steam to more than 1,800 ships, all using internal lubrication. Result—12 to 20 percent fuel saving."

The Admiral Anchor is described in Bulletin 104, published by the Admiral Anchor Company, 1417 Sansom street, Philadelphia, Pa. "The Admiral Anchor is simplicity itself—made of five parts. They are assembled by drawing the shank through the opening in the fluke, forcing the fluke pin through the cored hole in the fluke and shank and upsetting its end. The shackle and pin are placed in position, the pin ends upset and the anchor is complete. All parts made of anid open-hearth steel, having a tensile strength of 60,000 to 70,000 pounds per square inch, elastic limit of 45 percent of tensile strength, elongation of 15 to 25 percent and 20 to 30 percent reduction of area."

"How to Receive a Return from Investments That Shows Each Month" is told in a catalogue just issued by the Chicago Pneumatic Tool Company, 1044 Fisher building, Chicago, Ill. "When each month's power costs are checked against cubic feet of air compressed, 'Chicago Pneumatic' air compressors are shown to have made a substantial return of investment, for this very simple reason: every 'Chicago Pneumatic' is provided with automatic regulation, by means of which the power is varied to correspond with changing load demands. When those demands are light, down goes the power consumption; result—no waste of power, conservation of fuel energy, minimum power cost per cubic feet of air compressed. That saving will be effected the very first month you operate a 'Chicago Pneumatic' and every month thereafter throughout a long service life. Important as this may seem, it is but one of the distinctive features, among them 'Simplate' indestructible flat disc valves, which are resulting in consistently efficient operation at low maintenance cost by 'Chicago Pneumatic' air compressors, in all kinds of service throughout the world."

Hamilton Engines and Machinery are described and illustrated in a catalogue issued by the Hoven, Owens, Rentschler Company, Hamilton, Ohio. "For two years every effort was concentrated on the production of Hamilton marine engines for the United States Shipping Board. New methods of standardized production, disregard of outworn precedent, and a devoted personnel made it possible to put out, complete, 2,800-horsepower marine engines at the undreamed-of rate of four a week. The equipment of the plant where Hamilton engines are made is complete, modern and well balanced; it includes probably the finest and largest outfit of heavy machine tools in the United States. Hamilton engineers are in the front rank—each one a specialist of established reputation in his chosen field. All this means that the name 'Hamilton' stands for the utmost in design, efficiency and endurance."

The Starrett Hack Saw Chart "L" will be sent free to any of our readers upon request. "Follow the chart. Make your hack sawing just as efficient as any other machine tool operation. Choose your blade according to your work. You can't cut cold-rolled and heavy angle iron with the same blade without a waste. Whether you are cutting by power or by hand, big quantities of a comparatively few kinds and shapes of metal or smaller quantities of a lot of different things—there's a Starrett Hack Saw that will meet your needs most efficiently. Get the most out of every box of saws you buy. Use them for the purpose for which they were made."

"Agrippa" Turning Tool Holders and boring tool posts, "Vulcan" forged cutter tool holders and several new assortments of sets of drop-forged wrenches are described in a 160-page catalogue just issued by J. H. Williams & Company, 63 Richards street, Brooklyn, N. Y. This book contains also a description of the drop-forged process in simple, non-technical style, for the benefit of those not conversant with its details.

Albany Grease is described in a bulletin issued by Adam Cook's Sons, Inc., 708 Washington street, New York. "Albany Grease is used by marine engineers on the bearings of all kinds of equipment aboard ship, in shipbuilding plants, repair and drydock yards, regardless of temperature. This is made possible by the wide range of melting points to be had in Albany Grease. If the temperature at the bearing is high, No. X, XX or XXX Albany Grease should be used. For moderate bearing temperature use No. 2 or No. 3 Albany Grease. For cold-running bearings or for outdoor winter service, No. 0 or No. 1 Albany Grease will give satisfactory results. We will be glad to consult with you at any time on your lubricating problems. You are at liberty to draw on our experience of more than fifty years of If you are not using Albany Grease, why not let us send you samples without charge and try it?"

De Laval Steam Turbines with double reduction gears are described in Publication No. 46, just issued by the De Laval Steam Turbine Company, Trenton, N. J. "The following sister ships, *Piqua, Waukesha, Middlebury, Lynchburg, Marshal, Aurora*, each of 4,500 tons, are all equipped with De Laval 1,500-horsepower turbines, with double reduction gears designed for a propeller speed of 90 revolutions per minute. All of these boats exceeded their speed requirements on trial trips by a comfortable margin. The first vessel was placed in commission about a year and a half ago, and the last six months ago, and all the propelling units have proven entirely satisfactory, the gears being exceedingly quiet and the turbines economical of steam. Quietly operating gears mean correct design, correct cutting and correct support. Noise in gears is also a serious fault from the operator's standpoint, as noisy gears cause great inconvenience to the operating crews and make it very difficult to detect troubles that may occur in various parts of the engine room with auxiliaries, which would be instantly noted if the gears operated quietly. The great simplicity of the geared turbine drive likewise reduces expense for attendance. There are no complicated valve gears and no packing, and the oiling system is simple and automatic. No oil is introduced into the exhaust, thus reducing the attention required by condensers and boilers. State the type of vessel that you are building or contemplating, as we can probably refer you to similar vessels operating with De Laval geared turbines. We shall also be glad to supply data concerning weights, space requirements, efficiencies, etc."

"Marine Boiler Logic" is the title of a booklet issued by the Heine Safety Boiler Company, 5322 Marcus avenue, St. Louis, Mo. "As Admiral of the Fleet and later as the First Sea Lord of the British Admiralty, Sir John Fisher worked constantly to improve British naval construction. In the London *Times*, recently, he said, 'Was I wrong about the water-tube boiler when the whole expert world was against me?' Sir John was right in insisting upon water-tube boilers, as shown by the service they have given. Water-tube boilers were a vital factor in the British fighting ships that played an all-important part in the war. Reliability and efficiency must characterize the power plants of modern ships. These qualities are required for the successful operation of American vessels under conditions of peace. Heine marine boilers of proved reliability and efficiency are now available for ships carrying American merchandise and passengers. Their construction is explained in the new treatise, 'Marine Boiler Logic,' which also gives the fundamentals of marine power plant design. Send for your copy."

Marine and Stationary Steam Specialties are described in Catalogue 25, just issued by the McAlear Manufacturing Company, 1901 South Western avenue, Chicago, Ill. This company manufactures a large line of pressure reducing valves, steam traps, back pressure valves, grease extractors, pump governors, vacuum pumps, governors, automatic relief valves, chronometer valves, excess pressure pumps and other marine specialties.

The Revolvator is described in Bulletin 50, published by the New York Revolving Portable Elevator Company, Jersey City, N. J. "The Revolvator is a portable elevator or tiering machine. It consists of two uprights, an elevating platform and a revolving base, which can swing around on its own center like a turntable. This revolving base, which is fully protected by patents, is a distinct improvement over the old type non-revolving base machine, and makes the Revolvator 100 percent more efficient than the old-style tiering machine. A box or bale is placed on the platform when down, and by means of a crank and gears the platform is raised to any level desired and swung around on its own center, convenient for unloading. Rollers on the platform permit one man to slide the load from the Revolvator directly into the space where it is to be stored."

Rectangular Heavy Metal Storage Tanks for storage of lubricating, crude and paint oils, light paint, cutting oils and other non-volatile liquids are described in Bulletin 89, just issued by the Wayne Oil Tank & Pump Company, 589 Canal street, Fort Wayne, Ind. "The methods employed in the construction of heavy metal storage tanks have undergone considerable change in the last few years. This is especially true with the square or rectangular tanks. Breaking or bending the corners to exact alignment, shearing and punching so that in assembling the rivet holes come true, allowing the use of rivets of uniform diameter, internal bracing of the larger-sized tanks, mechanically figure so as to distribute the strain evenly over the entire surface, preventing bulging when the tanks are filled with liquid—is under the direct supervision of a competent engineer."

"Midwest Marine Power" is the title of a bulletin issued by the Midwest Engine Company, Indianapolis, Ind. "Those interested in the creation of marine power that is dependable, as well as economical, will do well to note the unusual facility of inspection and repair afforded by the equipment illustrated herewith. This is the four-cylinder Midwest Diesel marine oil engine, clutch type. It is also made in two- and three-cylinder sizes, and in the six-cylinder direct reversing type. The open crankcase makes it possible to remove pistons and piston rings without dismounting the cylinder heads or connecting rods. Simple, positive control for moving ahead or astern guarantees extreme flexibility of operation. Highest known efficiency is assured by the use of low-cost crude and fuel oils."

"A Problem and Its Solution" is the title of a booklet published by the Du Pont Chemical Company, Inc., Wilmington, Del. "The Du Pont war plants have shut down. They were fully equipped factories with every mechanical device giving satisfactory service. Their machinery, equipment and material are now offered for sale. Many items on the list can be used in your manufacturing or construction operations. Much of this apparatus is better than new. Careful operation has taken all the 'kinks' out of it. All of it has been tried and tested in actual service and found to be dependable. The cost of repairing a piece of worn-out equipment will pay for a Du Pont machine in good running order. The Du Pont Chemical Company now offers this peace surplus equipment at most alluring prices and for immediate delivery. Of course, it is impossible to give a complete listing in these pages. Our offerings are so varied that we suggest to the reader: 'If you don't see what you want ask for it.' It is highly probable that we can fill your requirements, but you must act quickly or you will miss some rare purchasing opportunities."

"The World's Standard Air Tools" is the title of a folder published by the Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, Ill. The superior points of Thor tools are stated to be as follows: "The only pneumatic drills made in this country having Corliss valves patterned after the Corliss engine; the only pneumatic drills made with roller bearings on each end of the crankshaft, reducing friction to a minimum; the only pneumatic drills having one-piece pressed vanadium steel connecting rods and pistons. Also equipped with removable crank chamber plate, allowing easy access to inside working parts. A telescopic screw-feed gives longer range in drilling. The only long stroke riveting hammer having a one-piece barrel and handle. Can't come loose."

The Ingersoll-Rand Company, 11 Broadway, New York, has issued the following bulletins describing its pneumatic tools: Form No. 8707—This is a 40-page, 6 x 9-inch bulletin on 'Little David' pneumatic drills, grinders and saws. Catalogue illustrates the various sizes and models of the different machines and contains detailed description concerning the particular tool to use for a given purpose. The descriptive matter is supplemented with a number of tables giving air consumption of the various tools, etc. Form No. 945—''Tis a Good Investment' is a subject of an 8½ x 11-inch form illustrating ER and FR compressors for small machine shops, power houses, garages, etc. Form No. 954—8½ x 11-inch sheet descriptive of the 'Air Lift Method of Pumping.'"

Marine Electric Fixtures are described in Catalogue 15, published by the Seidler-Miner Company, Detroit, Mich. "S-M electrical devices have become standard for marine work because of the excellent service which they give, combined with their economy. The design of the new line, shown herewith, is such that a minimum number of parts is required to make up a modern installation. Attention is called to the fact that prevailing W. T. Globe Fixtures consist particularly of two elements—the Globe holder and the body. The latter performs the function of an outlet box, which necessitates the use of a very large number of combinations of body and holder, to take care of the different requirements imposed on the body, as an outlet box. The S-M universal box, as described in this booklet, eliminates this disadvantage, requiring very few parts. It is designed to accommodate the standard wiring devices, always easily obtainable on the open market, and thus obviates the need of carrying a large and miscellaneous assortment of parts. The design of these appliances does not deviate from existing standards, but merely adds desirable features and decreases the assortment of parts. Many of these new ideas are protected by patents granted and pending."

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Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

Stop, Check and Emergency Valves are described in revised Catalogue 8B, just published by the Schutte & Koerting Company, 1158 Thompson street, Philadelphia, Pa. A copy will be sent free to any of our readers upon request.

Condensers, Pumps, Cooling Towers, etc.—Revised and enlarged Bulletin No. 112-B, entitled "Condensers, Pumps, Cooling Towers, Etc.," has just been published by the Wheeler Condenser & Engineering Company, Carteret, N. J. This bulletin illustrates the latest developments in condenser practice. It shows a surface condenser containing 50,000 square feet of surface. Sixteen condensers of approximately this size are now under construction. These will contain approximately 1,000 miles of Crescent Brand tubing drawn in the large Wheeler tube mill. The bulletin shows photographs of a number of actual installations of surface condensers. It illustrates and describes surface condensers, jet condensers, barometric condensers, the Wheeler-Edwards air pump, the Wheeler rotative dry vacuum pump, the Wheeler turbo-air pump, the patented Wheeler steam jet air pump, Wheeler centrifugal pumps for all services, jet condensers, barometric condensers, natural and forced draft cooling towers, feed-water heaters and Wheeler evaporators and dryers.

"Rugged Radio" is the title of a circular published by the Kilbourne & Clark Manufacturing Company, Seattle, Wash. "The popularity of K-C Radio is traceable solely to no one feature, but to many—each of great value. First, it is apparatus of unusual ruggedness—it is built to stand service. Second, it is compact—no more space than the corner of the average stateroom is required to accommodate it. Third, it is easy to set up—in a pinch, a set can be made ready to operate in a day. Fourth, the range is long—and this is a feature worth no small degree of consideration. For numerous ships are spending thousands of dollars needlessly each year because they are equipped with apparatus of inadequate range. The span for K-C Radio, two-kilowatt size, under normal conditions, is 2,000 miles with a 6,000-mile range under favorable circumstances. Fifth, K-C Radio is sold outright. This is the apparatus that made possible the general use of Radio. There are no tolls—no costly royalties—no annoyances. K-C Radio becomes the purchaser's property to use as much or little as desired. Sixth, K-C Radio is manufactured, backed and guaranteed by the largest radio manufacturer in the world—Kilbourne & Clark. Further particulars and catalogue on request."

"Rope That Satisfies" is the title of a pamphlet issued by the Plymouth Cordage Company, North Plymouth, Mass. "The last ninety-five years have wrought great changes in the cordage industry. Modern machines and the factory system have made possible a greater output and a better product than were even dreamed of in 1824. During these years manila fiber has established itself as the undisputed king of all rope-making materials. Uses for rope have greatly increased and a need has grown up for many different types of rope for many different tasks. People have come to appreciate that there are such things as good value and poor value in rope and have learned—often through bitter experience—that it pays in every way to buy the best quality. * * * All Plymouth Manila products are pure manila products in every sense of the word—unadulterated, unloaded, unmixed. The same purity of manufacture characterizes Plymouth Sisal products and all other goods that we make."

The White System of Burning Fuel Oil Mechanically is described in literature published by the White Fuel Oil Engineering Corporation, 742 East Twelfth street, New York. The company has made 660 installations on vessels of leading steamship companies, United States Shipping Board and United States Navy, including many of the largest steamships in the world.

HELP AND SITUATION AND FOR SALE

☞ *No advertisement accepted unless cash accompanies the order.*

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Wanted—Steel Tug, 100 to 115 feet long, 500 to 700 horsepower. New boat preferred. Address, giving full particulars, *P. O. Box* 477, Charleston, S. C.

College Graduate, scientific course, first-class traded machinist, experienced in marine engine construction, coal and oil firing; splendid health and physique; executive experience; success with labor; 34 years of age; married. Permanent connection desired, $55 week. Address Box 209, care of MARINE ENGINEERING.

Wanted—A High-Grade Superintendent for structural and plate shop, capacity one thousand tons per month. No one need apply who is not a first-class, well educated, thoroughly experienced man, with good references. Apply *Box* 807, care of MARINE ENGINEERING.

Marine Engineer—Wanted for an important and permanent position a high-grade marine engineer to take full charge of work. Excellent opportunity; large company; location New York. Address *Box* 28, care of MARINE ENGINEERING.

Wanted—Marine Auxiliary Draftsman, capable of designing steering engines. Permanent position. Give age, experience, education and salary expected. *The Main Electric Company,* 35 Commercial street, Portland, Me.

Wanted—Technical Graduate familiar with Marine Engineering specifications, first-class marine engine, electrical and pipe draftsmen. Permanent positions for right men in shipyard near New York City. Address *Graduate*, care of MARINE ENGINEERING.

For Sale—One 13-inch General Electric type P. C. thirteen, twenty-ampere, one hundred fifteen-volt direct-current searchlight, complete with rheostat, overhauled and in A-1 condition. Three 67-foot and three 75-foot cargo booms in good condition. Address *Freeport Sulphur Company,* Freeport, Tex.

Oil Engine Drawings for sale in full sets of standard shop working drawings. For 5,000- and 9,000-ton steamers, four-cylinder, 24 by 36, 1,450 horsepower, by 96 sheets, $1,200; for tugs, four-cylinder, 18 by 27, $1,000, and four-cylinder, 16 by 24, $900. For yachts or as auxiliaries, steel column crosshead type, 10 by 12, $900; 6 by 8, $600; 4 by 5 trunk piston, $300. Address *Fuel Oil,* care of MARINE ENGINEERING.

A Capable Ship Draftsman, with twelve years' experience in marine work, desires position as chief hull draftsman or hull inspector with a reliable shipbuilding company or steamship company. Must be permanent. Address *Box* 12, care of MARINE ENGINEERING.

Steamer Hull—iron, 328 feet long, 46 feet beam, 14 feet, 6 inches depth. *James Shewan & Son, Inc.,* foot of 27th street, Brooklyn, N. Y.

Good Proposition for Investors in the incorporation and development of patents in Marine Salvage. Write for further detail. Address *Box* 18, care of MARINE ENGINEERING.

Wanted at Once, Twenty Experienced Marine Draftsmen by a large shipbuilding corporation with a large amount of work on hand. Must have had marine engineering experience which will qualify for high-grade work. Send application, stating full experience and salary expected, to *Box* 55, care of MARINE ENGINEERING.

Wanted—By North Atlantic Shipyard, Draftsmen familiar with bilge and sanitary piping, steam heat and deck steam lines. Apply, stating experience and rate expected, *Box A-7,* care of MARINE ENGINEERING.

Naval Architect and Marine Engineer open for an engagement, wide experience abroad and in this country on all classes of marine construction. Address *Architect,* care of MARINE ENGINEERING.

Wanted—Well experienced and reliable draftsmen for Diesel engine work. Men with several years' experience on marine Diesels preferred. Give full account of previous experience, stating salary expected and age. Address *Box* 653, care of MARINE ENGINEERING.

Wanted—By a Delaware River shipyard, first-class man for engineering and estimating work. Man with technical training and shop and sea experience preferred. Addres *Delaware,* care of MARINE ENGINEERING.

Mechanical Engineer—Graduate of two colleges, has had full charge of materials in large Eastern shipyard, recently closed, wants position with engineering or contracting company. Can handle men. Will go anywhere. Age 29. Salary, $70 per week to start. *J. K. Smith,* West Park, N. Y.

Wanted—Several first-class hull and engine draftsmen. Good wages for good men, those with experience on Isherwood System preferred. Address reply to *Naval Architect, National Shipbuilding Corporation,* Three Rivers, Quebec, Canada.

Mechanical Engineer, during the last decade in charge of research and developing work on solid injection and Diesel oil engines, air compressors, etc., desires change. Leading and responsible position wanted as designing engineer. Excellent references. Address *Mechanical Engineer,* care of MARINE ENGINEERING.

To Represent United States Firms in Germany.—A leading Engineer in Europe, who superintended construction of largest vessels of the world, is in excellent position through acquaintance in highest steamship circles, shipbuilding and machine construction companies in Germany to represent American manufacturers of all kinds of machinery, tools and mill supplies, etc., and is willing to make arrangements as will satisfy American firms looking for representation. Write, giving full details, to *Chief Engineer L. Christlieb,* Schulweg 48, Hamburg 19, Germany.

"Spraco Painting Equipment" is the title of a bulletin published by the Spray Engineering Company, 93 Federal street, Boston, Mass. "Spraco Painting Equipment overcomes labor shortage. One man of average intelligence can do the work of 5 to 10 experienced painters with Spraco paint gun. And not only is there an appreciable saving in material but the job is done better, for the Spraco paint gun gets into every crevice and applies a uniform coat of paint. An average-sized job pays for the equipment. Send to-day for bulletin."

Pollak Steel Company Purchases Marion Rolling Mill

The Pollak Steel Company, Cincinnati, Ohio, announces the purchase, and the Interstate Iron & Steel Company announces the sale of its rolling mill property at Marion, Ohio, to the Pollak Steel Company. The sale comprises the land, buildings and machinery, all raw and finished materials and supplies located at Marion, and also the sales and purchase contracts of the Marion Works and the good will of the Interstate Iron & Steel Company.

The Pollak Steel Company was given possession of the Marion properties on December 1. The Pollak Steel Company states that the present organization of the Marion Works, of which O. O. Bell is works manager, and Mr. Verner works auditor, will be retained and that operations will continue the same as heretofore.

The Pollak Steel Company contemplates numerous improvements to the present Marion Works which is in line with its well defined progressive policy already demonstrated by its many improvements at its Cincinnati Works and the addition to its Chicago Works of a large drop forge plant for the manufacture of all lines of drop forgings and forge machine products.

The acquisition of this new plant gives to the Pollak Steel Company a wide variety of steel products, the Cincinnati Works specializing in the heavier forgings for railroad, marine and industrial service, the Chicago Plant all manner of drop forgings as well as the heavier forgings, and the Marion Plant producing all manner of rolled products.

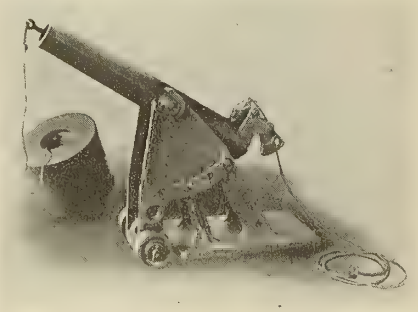
The Pollak Steel Company is a closed corporation, with Emil Pollak, president; Maurice E. Pollak, vice-president, and Julian A. Pollak, secretary, all located at the general offices, Cincinnati, Ohio. Bernard E. Pollak is treasurer and general manager, with offices at 120 Broadway, New York City.

The general sales and foreign offices, of which D. E. Sawyer is general sales manager, are also located in New York City, with district sales offices in all the principal cities in the United States.

Life Saving Gun Receives Endorsement of United States Steamboat-Inspection Board

In a series of recent tests made for the United States Steamboat-Inspection Board, the new G-O gun, produced by the General Ordnance Company, New York, for throwing life lines, fully met the requirements established by the board.

In one of the tests the cartridge case was immersed in water and then put into the gun and fired. In another the barrel of the gun was filled with water, the cartridge inserted and fired through the water, indicating that moisture does not damage the cartridge or mechanism in any way. A one-piece ammunition powder charge and projectile is used which eliminates the danger of moisture getting into the powder.



New G. O. Life Saving Gun

The gun is made in two parts: the cartridge and the barrel are so constructed that they can be moved from one part of a boat to another. The barrel can be carried by one man. Teeth on the bottom of the gun carriage hold it firmly in place during firing.

It is claimed that accurate shooting is possible up to a distance of 1,700 feet.

TRADE PUBLICATIONS

"The Oil Engine of the Future" is the title of a circular published by the Ingersoll-Rand Company, 11 Broadway, New York. "There is no doubt that the complexity of construction of the Diesel engine, and the intimate acquaintance necessary on the part of the engineer with each engine for its proper operation, has in the past been one of the reasons why more ships were not equipped with them. The methods of starting and reversing were not only complicated, involving shifting the cams, and differing on each make of engine, but frequently troublesome. Cylinder heads required special supervision by some one familiar with their construction in order to prevent abnormal temperature stresses and insure proper supply of fuel. The two- or three-stage air compressor necessary to supply air at 1,000 pounds pressure for fuel injection presented additional complications, while at the same time using at least 10 percent of the power developed by the engine. The Ingersoll-Rand oil engine presents the solution of this problem. It is very simple to operate and is started or reversed without shifting a single cam. It requires no special supervision of the cylinder head and valves, as it employs low compression pressures, and has, therefore, no extraordinary cooling problem. It employs direct injection of fuel, eliminating the problems connected with two or three-stage air compressors, and the possibility of air-bound fuel pipes, but has no hot bulb or cap. The P-R is as simple and dependable and as easy to operate and care for as the gas engine. Its fuel economy is as high as the Diesel, and it will burn very heavy fuel oils. The company is prepared to accept orders for early delivery of direct reversible marine engines from 200- to 600-shaft horsepower."

"How to Reduce the High Cost of Production" is the title of a leaflet published by the Pratt & Cady Company, Inc., Hartford, Conn. We quote as follows: "You are invited to attend a movement to perpetuate the good work started by the United States Government, during the war, to reduce the high cost of production by standardizing manufactures. It is to the advantage of manufacturers to do all possible to discourage the use of special sizes or designs which, in most cases, vary only slightly from the standard goods shown in their catalogues. For it costs more money to manufacture 'specials,' upsets manufacturing schedules, retards production and requires the time of labor which, in these days, is scarce and high priced. So why not urge your customers to use your Standard goods when they order Specials? And why not also follow the same course when you order goods? In our plant we are working hard to produce enough Standard goods to supply the big demand. But, to operate economically and with sufficient speed to supply the wants of our customers, Standard materials must be put through the factory on a quantity basis."

"Wire Rope" is the title of a bulletin issued by the Bourne-Fuller Company, Cleveland, Ohio. "If we did not know that Williamsport Wire Rope is equal or superior in quality to any wire cable ever produced, we would certainly not care to have our name identified with its distribution. If we did not believe that we can make good on our constant assertion that 'Bourne-Fuller Service is Efficient' we would not be wiling to direct your attention to it. The fact is that in point of uniform quality, conformity to every standard specification bearing on the manufacture of wire rope, The Williamsport Wire Rope Company, backed by the most modern wire drawing plant in America, delivers a product which has constantly made good wherever used. You cannot go wrong in using this rope The Bourne-Fuller Company is unusually well placed to serve your requirements in wire rope. In addition to prompt shipments from one of the largest factories in the country, we offer you for immediate shipment very large stocks of this product, located in various cities. Our most complete stocks are in Cleveland and Cincinnati, where we carry all sizes, all constructions, in all standard grades."

"**Westinghouse Underfeed Stoker**" is the title of a 36-page, 8½- by 11-inch booklet, with an attractive three-color cover, just issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa. Under the head of "Details of Construction" it gives a comprehensive description of the leading features of design contributing to the efficiency and reliability of operation. The interconnection of grates and tuyeres and the arrangement of brackets, gears and fuel deflecting plates, are clearly described. Taking up the principles of operation, the circular explains, by use of sectional cuts and charts, the distinctive features of the Westinghouse zone system of air distribution. The subjects of "Efficiency" and "Capacity" are taken up together with "Flexibility." Curves setting forth extensive performance data relative to these subjects and others are used to amplify the text. Under the subjects of "The 'Coal-Saving' Problem" and "Fuel-Burning Equipment of Modern Power Stations," an interesting and instructive array of information is given for the benefit of those who have the operation of stokers in charge. A large list of representative installations making use of these stokers is another prominent feature. It is plentifully illustrated.

"**Drill Salvage—The First Aid to Rising Shop Costs,**" is the title of a circular published by the Rich Tool Company, Railway Exchange, Chicago, Ill. "The mortality of shop tools is a subject to which you have given much thought. Drills and reamers will wear and break and accidents will happen. Perfectly good drills will break off at the shank or a perfectly good shank must be discarded when the drill is damaged or worn out. It is to meet these ever-present conditions that we have designed the Rich No. 22 two-piece interchangeable drill, which makes it possible to conveniently and economically reclaim your broken shank drills and thus place your shop costs on a lower level. The blade of the Rich No. 22, in common with all Rich products, is forged from the bar at the proper temperature, and is fitted with a straight thread and a taper which engage a similar thread and taper in the shank. The thread does not seat. The taper takes the thrust. This shank can be furnished standard or oversize, making it possible to use drills to which you can adapt either standard or oversize shanks as desired. Positive alignment is assured. If the blade wears out or is accidentally broken, you do not have to buy a whole tool. The blades or shanks may be obtained separately. Your broken shank drills can be fitted to these sockets. Rich products consist of taper and straight shank drills and reamers; track and bonding bits, countersinks and rivet sets in a wide range of sizes and styles, and as they are built to give maximum and uniform results, they are adopted as Standards in shop equipment of their character."

Zinc Plates for use in the shipbuilding industry are described by the New Jersey Zinc Company, 160 Front street, New York, in a circular just published. "Our numerous mines yield such a comprehensive variety of zinc ores that we are able to exactly meet every zinc requirement. Our rolling mills at Palmerton, Pa., are now prepared to furnish zinc ship plates and boiler plates of any desired dimensions and thicknesses and of just the right quality to best serve their purpose. This organization, with its extensive resources and its seventy years of experience in the development and production of zinc products, has unusual advantages in meeting the needs of the ship building industry."

"**How Some Shipowners Increase Their Profits.**" This is the title of a 48-page book illustrated in colors and published by the Diamond Power Specialty Company, 58 First street, Detroit, Mich. This book is written particularly for owners, managers and superintending engineers as well as for vessel chiefs. It deals first with the relation of boiler efficiency to coal consumption and to steaming radius. It then discusses the relation of soot to boiler efficiency, and after an interesting review of the soot problem discusses Diamond soot blowers for all types of boilers in considerable detail. Copies may be had on application to the company in Detroit or by addressing F. W. Leahy, Marine Manager, 32 Broadway, Room 1611, New York City.

A Band Ship Saw is the subject of Bulletin N-19, issued by the J. A. Fay-Egan Company, Cincinnati, Ohio. "Foresightedness and ability to mobilize its resources quickly enabled the Fay-Egan organization to perform a great public service. For many years there had been absolutely no demand for machines for building wooden ships. The old models had become obsolete and had been discontinued. In this class of work a heavy bevel cutting band saw forms the most important item of equipment; in fact, in the smaller yards, generally, it is the only machine used. With the first signs of a shortage of ocean tonnage our engineering department, foreseeing a shortage of steel and a resulting revival of wooden hull ships, started to develop a line of machines adapted for working timbers of hitherto unheard-of sizes in shipbuilding. Especially noteworthy was the No. 311 Band Ship Saw, and when the shipbuilders and lumbermen began thinking about wooden ships of large size, details of this machine had been completed and construction started. The first lots of these machines produced were quickly taken up, and when the United States Shipping Board was organized wooden ship construction was already well under way, and twenty Fay-Egan 'o. 311s in operation. Now there is practically no yard of consequence in either the East, West or Gulf Coasts, in Canada, and even Japan, that is not already operating a No. 311. When history shall have written the events of these years, it may develop that the 'bit' done in advance by the Fay-Egan organization will have played an important part in the future of the peoples of the earth."

A Circular Addressed to Shipbuilders has just been published by Whittelsey & Whittelsey, naval architects and marine engineers, Whitehall building, New York. "Many of our clients are shipyards, who have found that the employment of our engineering and drafting departments results in better work at lower cost than if they maintained similar departments of their own. That we are rendering a valuable service to our shipyard clients is evidenced by the fact that we are at present handling contracts aggregating upwards of $4,000,000. In general, our organization is qualified to serve you in the following ways: 1. Preparation of preliminary plans and calculations for assisting in obtaining new business. 2. In preparing complete designs from the inception of the lines, all calculations, handling of model tests and machinery installations. 3. Fabrication. We have specialized and have a most competent organization for handling of full fabricating plans; and in one case we were able to so systematize that a saving of $25,000 was made in the cost of fabricating three steel ships. 4. Paneltype ship. We are prepared to have licenses issued for construction of the panel-type ship, which obviates the necessity of any fired work; that is the simplest form of construction known, and which may be classed in any of the classification societies. 5. Diesel engine power plants. Our Marine Engine Department, headed by one of the most experienced Diesel engineers, has saved many thousands of dollars for our clients. We have lately designed a 1,900 indicated horsepower full Diesel engine based throughout on principles employed in European practice, established through years of successful operation at sea. Inquiries regarding this engine design are solicited."

"More Cargo Space" is the title of a circular published by the Standard Oil Company of New Jersey, Fuel Oil Department, 26 Broadway, New York. "Steamers burning fuel oil need less bunker space and less weight of fuel than coal burners. They provide more cargo space in ships of equal register and develop greater speed and steaming radius. They require a smaller stoke hole gang. Standard fuel oil for bunker use is carefully refined—feeds freely and evenly—furnishes clean, intense heat—assures ample steam and maximum speed from dock to dock—and smaller costs for every hour at sea. This company is in a position to make deliveries at North and South American ports as well as European ports."

Marine Hardware and Specialties are described in Catalogue B, just published by the William V. Dee Company, Bridgeport, Conn. "We have successfully developed standard hull fittings for merchant vessels. Our line includes water-tight doors with fittings, engine room skylight lifting gears, mess and galley lifting devices, toggle pins, skylight and other forged hinges as described and illustrated in the following pages. We are also developing other items, such as standard mast and boom fittings, rail and awning stanchions, manholes non-watertight doors, thrust recess bulkhead doors and operating gear, and miscellaneous materials which will, in due course, be available as standards. The standards already developed have been widely adopted, and in our judgment the success in the future of the merchant marine will, in a large measure, depend on high-grade standard materials that are turned out on a commercial basis (finished articles) at reasonable prices. While we manufacture many items including our standard fittings, we can also supply a full line of ship chandlery beside representing in the marine field a number of specialty manufacturers. Your inquiries or blue prints for estimates on work requiring machining or castings of any kind will be given prompt attention, and our facilities are such as will insure high-grade workmanship and materials."

Nelson Valves is the title of a profusely illustrated cloth-bound catalogue of 156 pages published by the Nelson Valve Company, Chestnut Hill, Philadelphia, Pa. "A valve is a more important part of power equipment or other piping installations than many owners and managers at first recognize. There has been quite a widespread attitude that 'a valve is a valve,' and a tendency when purchasing this class of material to call on the handiest source of supply for 'just valves' and to be guided in selection largely by price. Such practice only leads to expense in maintenance and operation later on, for much money can be spent on poor valves and troubles resulting from them, far in excess of slight differences in first cost. Present severe demands on such engineering equipment are bringing about a more general and forceful realization of these facts. Nelson valves are made with recognition of the fact that a valve is really a very important part of engineering equipment. The Nelson line is based on the principle that refinements of design and construction of a valve, as well as other equipment, pay for themselves in Service, which is the real thing that is purchased and sold, and that cheap, inferior work and skimping of materials is poor economy for both the user and the manufacturer. High standards are set for Nelson valves, and they are built to standards rather than down to price. Our constant aim is to make every Nelson valve a thoroughly good valve, and to render real, satisfactory service to our customers."

Two-Bearing Over-All Equipment made possible by the Use of the Steam Motor, is the subject of a folder published by the Steam Motors Company, Springfield, Mass. "We would like to call your attention to our leaflet describing two-bearing over-all equipments made possible by the use of the Steam Motor. Our main object in adopting this construction is to produce the most reliable and simple equipment possible and also eliminate the vibration and misalignment troubles encountered in four-bearing units made up with a 'flexible' coupling. That these troubles are eliminated has been proven in the hundreds of sets now in operation. The Steam Motor is manufactured in all sizes up to 300 or 400 horsepower, depending upon operating conditions, and is designed for operation at any desired speed, either by direct connecting to the driven apparatus or by connecting through speed reducing gears. We would appreciate the opportunity of quoting on your requirements covering turbines for driving pumps, fans, blowers, generators and mechanical drive, or we can quote you on complete equipments should you desire. We would also suggest that when purchasing equipment of the type referred to above that you specify Steam Motor driven two-bearing equipment. We would be very glad to have one of our engineers call and discuss matter with you in detail if you desire."

"The Engineer's Best Friend" is the claim made by the American Steam Gauge & Valve Manufacturing Company, Camden street, Boston, Mass., for the American Thompson Improved Indicator. "The parallel motion of the American Thompson improved indicator is by far the most accurate in existence. The errors which usually exist in drawing correct vertical lines with other indicators cannot possibly appear in the limited movement of the pencil in taking diagrams from a steam engine with the American Thompson indicator. The parallel movement of the pencil is secured by a link attached to and governing the lever direct. The pivots of this link are made free from any appreciable lost motion, and will remain so indefinitely; but if any lost motion should exist, it will affect the integrity of the parallel movement only to an extent equal to it, not three or four times that amount. In other movements where the parallel movement is affected by controlling the connecting rod, either by a curved slot in it and a guiding roller, or by attaching the link, the parallel movement becomes dependent for its accuracy on the fit of several parts, play in any one of which will cause an uncertainty and probable inaccuracy equal to three or four times the amount of such play. The force required to guide the lever of the American Thompson improved indicator in its parallel movement is received on the pivots of the link alone. In cases of the slot and roller device, this guiding force is received in several rapidly moving surfaces and multiplied in amount of leverage. The same is also true to a considerable extent where the link is attached to the connecting rod. The pencil lever has a ratio of three to one and is constructed as light as possible. It is guided by a short connecting link, which is fastened to the stationary arm or post of the parallel motion and is connected to the piston rod by a yoke provided with a hole slotted to take the indicator lead."

Crank Case Oil Bulletin No. 102 and Marine Bulletin No. 103 are published by the De Laval Separator Company, 165 Broadway, New York. "The De Laval Method of Oil Purification is a remarkable means of removing impurities from lubricating oils, restoring them to their original lubricating qualities. The oil purifier is used on all kinds of ships, from U. S. destroyers to motor-driven freighters. It is being put on old ships and ships now building; it keeps the lubrication system free from impurities. It purifies all kinds of oil equally well and removes all kinds of impurities, such as dirt, water, carbon, core-sand, pipe-scale, metallic particles, etc. The De Laval oil purifier is not affected by the motion of the ship. It is furnished in three sizes, each size in either electric, belt or direct steam turbine drive."

Gasoline Paint and Lubricating Oil Storage is the subject of Bulletin 95, published by the Wayne Oil Tank & Pump Company, 589 Canal street, Fort Wayne, Ind. "Storing, handling and selling paint and lubricating oils is to-day as much of a science as is the manufacture of these oils. The up-to-date dealer should realize the fact that each drop of evaporated, dirty or spilt oil is a loss of profit to himself. Just how to acquaint the dealer with these essential facts is made self-evident from absolute facts and figures, as shown on the opposite page. To eliminate evaporation, dirt, spillage, fire danger, absorption, incorrect measurement, loss of labor, loss of space, incomplete drawing of barrel contents, and finally the loss of the barrels themselves, there is but one logical solution. The self-measuring, air-tight, fireproof, compact, speedy and easily operated pump and tank solves the problem in a clean, inexpensive and profitable manner. The installation of either the first floor or long-distance pump and tank guarantees to the purchaser a method of storage, handling and selling oils with absolute safety, perfect measurement, greatest speed, least labor, practically no spillage or evaporation and requiring minimum floor space. The proof of any and all of these statements is so evident, when a careful study of fundamental costs and selling prices are considered, as to make lengthy explanation unnecessary."

"Superheated Steam" is the title of a pamphlet issued by the Power Specialty Company, 111 Broadway, New York. This publication covers the following subjects: The possible percentages of steam savings and corresponding fuel savings through the use of superheat. How plants should be laid out for the maximum benefits of superheat. The theory of the effect and protection of superheat and engine cylinders and in turbine blades and vanes. Suitable material and sizes for lines and fittings in connection with superheat. Pressure drop from pipe friction and how reduced by superheat. What to look for and what to look out for in choosing a superheater. The theoretical and practical superiority of Foster Superheater construction with regard to both high efficiency and permanent care-free service. This book is written in simple language and filled with information that every well informed steam user ought to consider seriously.

The discussions of subjects indicated at the left show the way to important economies and possibilities, and there is a further discussion of superheater construction which is very important to those who seek the full and lasting undiminished benefits from the intelligent use of superheat. Foster Superheaters are built now in the light of 20 years' American experience by the pioneers in superheater development, and have been the recognized leaders from the very introduction of superheat. Their correct use affords one of the best possible means of combating present-day high fuel and power plant labor costs, so the question of getting the benefits of superheat is now more urgent than ever. Let us refer you to some of the 9,000 satisfactory Foster Superheater installations. If you are responsible for marine power plant design or management, send for this book and tell enough about your plant so that we can give you free but valuable advice.

"The De Laval Oil Purifier" is described in Marine Bulletins Nos. 102 and 103, published by the De Laval Separator Company, 165 Broadway, New York. "The De Laval centrifugal oil purifier is simple in construction and operation. This simplicity means long life and freedom from repairs, and is the outcome of over forty years of unquestioned leadership in the manufacture of centrifugal machines. The De Laval oil purifier is the simplest and, at the same time, the most effective means of eliminating grit, dirt, carbon, water and other impurities from crank-case and other lubricating oils, instantly restoring them to original usefulness. The oil purifier is built in three sizes, and with electric, belt or direct-steam turbine drive. It occupies less than two square feet of space and uses very little power."

Rainbow Acetylene Hose is one of the many varieties of rubber hose described in bulletins published by the United States Rubber Company, 1790 Broadway, New York. "There is a brand of United States Rubber Company hose to meet every marine requirement. Rainbow acetylene hose is a light, flexible hose that will not kink when bent abruptly, and that has a great margin of safety over the pressure normally met in welding. The cover is designed to withstand the abrasion met in shipyards, and is colored red or black to designate oxygen or acetylene lines respectively."

The Burke Electric Company, Erie, Pa., manufacturer of direct- and alternating-current machinery, has issued a folder giving a list of some of the motors and generators in stock, and also showing some of the alternating-current motors nearly completed for stock, which can be shipped within two weeks. They state, "There is in addition a constant procession of partly finished machines in process coming through the works, enabling us to make prompt shipment of many sizes not in stock. Your inquiries are solicited and welcome for information on electric generators and motors to suit your own specific requirements, both alternating and direct current, and from 1,000 kilowatts down to the smallest household motors."

Automatic Oil Circulating and Filtering Systems are described in Bulletin S-25 issued by the Richardson-Phenix Company, 120 Reservoir avenue, Milwaukee, Wis. "After fifteen years of engineering and manufacturing experience—years of pioneer work in the development of scientific lubrication—the products of the Richardson-Phenix Company have come to be recognized as standard and Richardson-Phenix lubrication engineers as the final authority on all problems pertaining to scientific lubrication. In order that all products and all literature and advertising of this company may be instantly identified, our new trade-mark has been adopted. This mark is more than a mere label—it is a symbol of a service we alone can render, a service that embraces every branch of scientific lubrication, the correct application, reclamation and handling of lubricating oils. It stands for the highest development of one of the most important contributions in the industrial world. It represents a great advancement in engineering science."

The Application of Superheated Steam to Marine Engines is the subject of an illustrated booklet published by The North Eastern Marine Engineering Company, Ltd., Wallsend-on-Tyne, England. The advantages to be gained by fitting superheaters are set forth in this catalogue as follows: "With either turbine or reciprocating engines there is saving in steam consumption by using superheated steam instead of saturated. There is also a saving in fuel consumption, either with coal or oil, due to the smaller quantity of steam to be produced. Due to the decreased consumption, the size of the boilers may be reduced for equal powers, or alternatively a greater power may be developed with the same size of boilers. The bunker capacity may also be reduced, and, if necessary, the carrying capacity of the vessel correspondingly increased. The losses due to cylinder condensation in reciprocating engines are avoided by using superheated steam, resulting in a dry engine platform, with no water running from piston and valve rod glands. With steam turbines the use of superheated steam reduces the possibility of erosion of the blading caused by the impact of particles of water carried with the steam, as in the case of wet steam. With superheaters fitted to coal-fired boilers there is less fluctuation of pressure when cleaning fires, and the full boiler pressure may be more constantly maintained at the maneuvering valves. With either turbine or reciprocating engines, in order to obtain maximum economy it is necessary to use superheated steam. This has for long been recognized in connection with electric generating stations on land, and has also been clearly proved in marine installations. Superheaters are being fitted in all the new construction of our largest and most progressive shipping concerns."

Sturtevant Steam Engines are described in Special Catalogue No. 239, just published by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. "Sturtevant steam engines are now made in two types only—VS-7 and VS-8 (vertical, single cylinder). All others have been eliminated to enable us to meet the demand for these two types. The difference between these two is one of lubrication—VS-7 is gravity, while the VS-8 is forced feed—both systems have their friends. These engines were designed to fulfill the U. S. Navy specifications, which means that they must have the utmost reliability under all conditions of service. Our engine department was 100 percent engaged in Government work, and we are proud of the fact that our standard engines were accepted without a single alteration. These engines are both used for direct connections to blowers, fans, generators, and for independent power service, automatic and throttling."

Tackle Blocks are described in an illustrated catalogue published by the Parish Supply & Manufacturing Company, 2856 Quinn street, Chicago, Ill. "We make tackle blocks with a safety factor of five to one. The safe working load of each block with shackle fitting is equal to that of the best quality manila or plow steel wire rope used, with a safety factor of five to one. Scientifically built to stand the strain of strenuous service, Parish dependable tackle blocks mean safety to life and property —ease and smoothness in handling all loads—and enduring economy in operation."

The Benson Electric Telemotor is described and illustrated in a bulletin issued by the American Engineering Company, Philadelphia, Pa. "Electric control is the ideal form of transmission. It insures more sensitive control and greater ease of operation than any other. It relieves you of worry about air traps or temperature conditions. It eliminates the necessity of keeping a long line of shafting and gears in perfect alinement. Stretching will not in any way lessen its effectiveness, so that point need not worry you. It is so simple that it is almost impossible to get it out of order."

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 428 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 808 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
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Grand Conductor—J. W. McLeod, Owen Sound, Ont.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

HELP AND SITUATION AND FOR SALE

☞ *No advertisement accepted unless cash accompanies the order.*

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Wanted—Steel Tug, 100 to 115 feet long, 500 to 700 horsepower. New boat preferred. Address, giving full particulars, *P. O. Box* 477, Charleston, S. C.

Naval Architect and Marine Engineer open for an engagement, wide experience abroad and in this country on all classes of marine construction. Address *Architect,* care of MARINE ENGINEERING.

Wanted—By a Delaware River shipyard, first-class man for engineering and estimating work. Man with technical training and shop and sea experience preferred. Addres *Delaware,* care of MARINE ENGINEERING.

A Capable Ship Draftsman, with twelve years' experience in marine work, desires position as chief hull draftsman or hull inspector with a reliable shipbuilding company or steamship company. Must be permanent. Address *Box* 12, care of MARINE ENGINEERING.

Wanted — Technical Graduate familiar with Marine Engineering specifications, first-class marine engine, electrical and pipe draftsmen. Permanent positions for right men in shipyard near New York City. Address *Graduate,* care of MARINE ENGINEERING.

Marine Engineer—Wanted for an important and permanent position a high-grade marine engineer to take full charge of work. Excellent opportunity; large company; location New York. Address *Box* 28, care of MARINE ENGINEERING.

Position Wanted as Purchasing Agent — Seventeen years' shipyard, railroad and manufacturing experience. Stores and shop systematizer. New construction and repairs. References furnished. Address *Box* 48, care of MARINE ENGINEERING.

To Represent U. S. Firms in Germany—A leading engineer in Europe, who superintended construction of largest vessels of the world, is in excellent position through acquaintance in highest steamship circles, shipbuilding and machine construction companies in Germany, to represent American manufacturers of all kinds of machinery, tools and mill supplies, etc., and is willing to make such arrangements as will satisfy American firms looking for representation. Write, giving full details to *Chief Engineer L. Christlieb,* Schulweg 48, Hamburg 19, Germany.

Chief Hull Draftsman, open for position with live-wire company. Thorough knowledge of estimating, designing and construction of tankers, cargo and passenger ships. Practical knowledge of marine engineering. At present employed. Address *C. H. D.,* care of MARINE ENGINEERING.

Hull Draftsman, 12 years' experience, wants position as charge man or production engineer, vicinity of New York or New England. Address *Draftsman, Box D*-12, care of MARINE ENGINEERING.

Marine Chief Engineer, with most exceptional sea repair experience, all parts of the world, requires permanent position. Thorough machinist. Take entire charge of Ship Repair Yard plant. Address *Box M*-1, care of MARINE ENGINEERING.

Wanted at Once, Twenty Experienced Marine Draftsmen by a large shipbuilding corporation with a large amount of work on hand. Must have had marine engineering experience which will qualify for high-grade work. Send application, stating full experience and salary expected, to *Box* 55, care of MARINE ENGINEERING.

Mechanical Engineer—Graduate of two colleges, has had full charge of materials in large Eastern shipyard, recently closed, wants position with engineering or contracting company. Can handle men. Will go anywhere. Age 29. Salary, $70 per week to start. *J. K. Smith,* West Park, N. Y.

Oil Engine Drawings for sale in full sets of standard shop working drawings. For 5,000- and 9,000-ton steamers, four-cylinder, 24 by 36, 1,450 horsepower, by 96 sheets, $1,200; for tugs, four-cylinder, 18 by 27, $1,000, and four-cylinder, 16 by 24, $900. For yachts or as auxiliaries, steel column crosshead type, 10 by 12, $900; 6 by 8, $600; 4 by 5 trunk piston, $300. Address *Fuel Oil,* care of MARINE ENGINEERING.

The Waterbury Rope Handbook is a 122-page cloth-bound manual published by the Waterbury Company, 63 Park Row, New York. In it may be found a great amount of information on the subject of wire rope. "Splicing a wire rope, rigging a thimble, sheave and drum tables, comparative strengths, factors of safety, construction and lays—anything else you might want to look up about wire rope is there in 'quick-findable' form in the Waterbury Rope Handbook, a 220-page cloth-bound manual with more rope dope in it than can be found between two covers anywhere else. And a copy will be sent free at your request. The Waterbury Company has only one standard for the rope it makes—quality. Grade for grade, Waterbury wire rope, like every other Waterbury rope, has no superior."

"Monel Metal" is the title of a booklet published by the International Nickel Company, 43 Exchange Place, New York. "Monel Metal is a natural alloy of nickel and copper—non-corrodible—strong as steel—tough and ductile. Withstands acids, high temperatures and erosive action of hot gases and superheated steam. Can be machined, cast, forged, rolled, drawn, brazed, soldered and welded—electric or oxy-acetylene method. Takes and retains a perfect nickel finish. Monel Metal is manufactured in the form of rods, castings, forgings, wire, strip stock, sheets, etc. In the marine field Monel Metal has proved its immunity from the corroding action of water, steam or acids and from salt-air exposure. Also, its superiority over other metals for pump rods, pump lines, valves and valve seats, and for use in exposed locations on shipboard, such as stair-nosings and hand rails. The Monel booklets show many other uses for which Monel has proved superior."

Power Machinery is listed and priced in a catalogue recently issued by MacGovern & Company, Inc., 114 Liberty street, New York. The prescript to this catalogue states: "The pages list a stock of high-grade power machinery unequaled in scope and diversity and ready for immediate shipment. Each item here listed will go to its purchaser with the MacGovern guarantee that it is exactly as represented—a guarantee backed by a responsibility equal to that of the original manufacturer of the machine. This guarantee is based upon inspection, prior to purchase by this company, by competent engineers selected for their knowledge and experience of the particular class of machine. This inspection permits sale of each item with positive knowledge of its operating condition and with a definite understanding of the service it still is capable of rendering. We are the largest dealers in used power machinery in America. Our methods, our reputation, our responsibility, our volume of business, have given us this commanding position in the re-sale markets. No one concern manufactures all the classes of apparatus we sell. Yet we have built up an engineering organization which has repeatedly proved its ability to advise with authority upon the selection, installation and operation of any machine offered. This engineering service—free to our customers—is one part of the 'plus' value offered the trade, and has been a large factor in the uniform satisfaction that has followed purchases made from us. Financial responsibility—unequaled stock—expert engineering service—immediate shipment—these are the four obvious reasons for the purchase of MacGovern power machinery. We invite, and strongly urge, inspection of apparatus by the prospective buyer, and we will reserve under option when this is done. Otherwise, all items here listed are subject to price change without notice, and are offered subject to prior sale."

General News and Technical Notes

BIG SHIPYARD SOLD

Pusey & Jones Plant Bought By Baltimore Dry Dock and Shipbuilding Company

The Pusey & Jones shipbuilding plant at Gloucester, N. J., has been purchased by the Baltimore Dry Dock & Shipbuilding Company, according to advices just received from Baltimore.

The plant, which has 1½ miles of waterfront, and covers 179 acres, comprises the former property of the Pennsylvania Shipbuilding Company and the New Jersey Shipbuilding Company. It has eleven shipways, and has a complete equipment for the construction and repair of vessels of all sizes except the very largest. The purchase price was not named but the property represents an investment of $5,000,000.

Formal transfer will be made on the settlement of differences between the Pusey & Jones Company and the Shipping Board over construction contracts canceled by the Board. The Wilmington, Del., plant of the Pusey & Jones Company is not affected by this deal.

1,000-FOOT PIERS PLANNED

Providence, R. I., Working for Big Improvements

Plans for the development of important port facilities at Harbor Junction, in South Providence, are being seriously considered. Tentative plans have been drawn for three 1,000-foot piers, at the property of the New Haven Railroad lying along Allen's avenue, and include a terminal warehouse and trackage connecting with the New Haven tracks. The plans are being developed by Jonathan Starr, of New London, Conn., representing the Eastern Terminal Corporation. This concern has recently secured land on Branch avenue for the construction of a warehouse, and is engaged in similar undertakings in Boston, New Haven and New York. The development would be begun by the building of one pier and the warehouse, and additional facilities would be added as needed. It is probable that the plans would include a grain elevator, which the Providence Chamber of Commerce is working for. Mr. Starr holds that the prospects of the port call for a large addition to its present facilities and justify plans for 1,000-foot piers to take care of increased tonnage.

New Piers at Camden, N. J.

Under the guidance of Mayor Charles T. Ellis, of Camden, N. J., a vigorous programme of improvements is being put through by the City Council, including two new piers to class with the largest on the Delaware River. Contracts have already been let for these piers, which are to be 350 feet long, and between the present Spruce street and Walnut street wharves. The northern pier will accommodate a ship 600 feet long, and the southern pier a ship 480 feet in length. The plan also calls for a big marine terminal, the entire project to cost $3,000,000. A bond issue of $500,000 has already been authorized, and work will begin as soon as weather conditions permit.

WILL BE OIL BURNERS

Union Steam Ship Company's Fleet Being Altered

Work has begun at the Union (San Francisco) plant of the Bethlehem Shipbuilding Corporation, Ltd., on changing from a coal burner to an oil burner the 8,000 gross tons steamer *Tahiti*, of the Union Steam Ship Company, of Dunedin, N. Z. This is the first of the three steamers on the run between Australia and San Francisco to be changed, and the other two will be overhauled and converted as soon as possible. Then, the officers say, they will be able to keep the ships clean. Although there has been no official announcement to that effect, it is believed in San Francisco that the Union Line intends to convert every vessel it owns into an oil burner.

There are 59 vessels listed in the Union Steam Ship Company's fleet, ranging from the 13,415-ton *Niagara* and the 12,269-ton *Armagh*, down to the 260-ton *Terawhiti* and the 112-ton *Tuatea*, all except three small ones having been built in United Kingdom yards.

The restoration of an adequate service between San Francisco and Australia will divert a large volume of travel from the Suez route to San Francisco, according to Sydney advices. Owing to the movement of troops from Europe the facilities of the westbound lines from Sydney are crowded, and the civilian and commercial travelers have little choice offered.

RED CROSS HONORED

Freighter Named After Organization's Cable Address

The *Amcross* is one of the latest acquisitions to the United States Merchant Marine. She was launched at the yard of the Merchant Shipbuilding Corporation at Chester, Pa. Amcross is the cable address of the American Red Cross, and was designated as the name of the new ship by the Shipping Board, under whose supervision the vessel was built. Miss Margaret Farrand, daughter of Dr. Livingston Farrand, chairman of the Central Committee of the Red Cross, broke the time-honored bottle over the ship's prow as she started down the ways.

The *Amcross* is a standard fabricated steel cargo vessel having a loaded displacement of 12,415 tons, 401 feet long, with 54-foot beam and a depth of 34 feet. She is of 9,000 deadweight tons, and will have a speed of 11 knots. The keel was laid on May 26, 1919.

Handy Indicator Cord Hook

An indicator cord hook has recently been developed and patented by the Trill Indicator Comapny, Corry, Pa., which enables the engineer quickly to connect the indicator cord with the crosshead of a high speed engine.

The three accompanying illustrations clearly show how the hook is attached while the engine is running. The loop of the hook is held between the thumb and the finger as illustrated in Fig. 1, in such a position as to allow the pin on

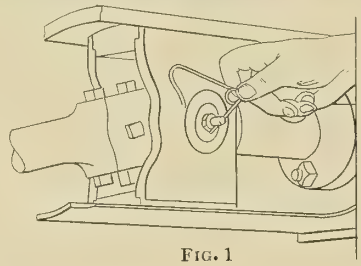


Fig. 1

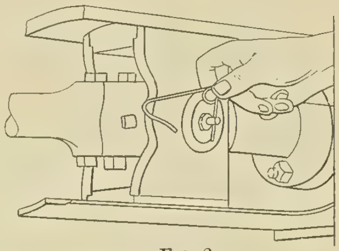


Fig. 2

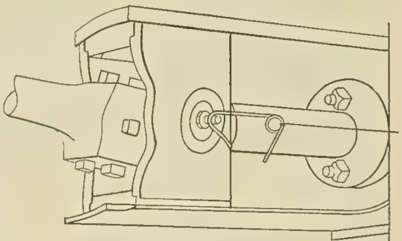


Fig. 3

Handy Indicator Cord Hook

the standard to strike the straight part of the hook when the standard is within about one inch of the end of the travel. The hook swings about the thumb and finger as a pivot, as illustrated in Fig. 2, which action shoves the hook downward. At that instant the piston has reached the end of its stroke. On the return stroke, the pin on the standard engages the hook as illustrated in Fig. 3, and the attachment is complete.

GOVERNMENT DISPLAYS AT MARINE EXPOSITION

Shipping Board and Department of Commerce to Have Exhibits

The United States Shipping Board will be represented at the forthcoming National Marine Exposition, in the Grand Central Palace, this city, April 12-17, 1920, by an elaborate three-part exhibit which will depict all phases of the Shipping Board's work since its inception. A special committee to prepare the exhibit has been appointed by Chairman Payne. Official co-operation of the Shipping Board has been further extended by the consent of Chairman Payne to open the exposition in person.

The Department of Commerce will be represented by the exhibit of the Steamboat Inspection Service, the Bureau of Navigation, the Bureau of Fisheries, the Bureau of Lighthouses, and the Coast and Geodetic Survey. Important features of the Department of Commerce's exhibit will be lifeboats with full equipment required by the Steamboat Inspection Service on passenger vessels; fog horns, lamps and lenses employed in the lighthouse service, models of old-time fishing and whaling vessels and instruments, side by side with modern vessels and equipment employed in the fishing industry, and a remarkable radio compass just perfected by the Bureau of Standards for the Bureau of Navigation. Moving pictures of the United States Government's seal herds in the Bering Sea will be shown, one scene showing 6,000 seals taking to the water at one time.

Tentative plans for the decoration of the Grand Central Palace, where the exposition will occupy several floors, call for the flying of the house flags of all American steamship companies.

Pratt & Cady Branches

Announcement is made by the Pratt & Cady Company, Inc., of Hartford, Conn., of the appointment of Mr. E. Coit Magens as director of sales; Mr. O. Lamson Beach as manager, metropolitan store, 259 Canal street, New York City; Mr. Quay T. Stewart as sales representative, Minneapolis, Minn.; Mr. Henry J. Bride as sales representative, Hartford, Conn.; also the opening of branch stores at 529-531 Arch street, Philadelphia, Pa., Mr. H. H. Freund, Jr., manager; 505 Mission street, San Francisco, Cal., Mr. C. R. Mendelson, manager. In addition to their established lines of Renewable Disc Globe Valves, Renewable Seat Gate Valves, Regrinding Swing Check Valves and Asbestos Packed Cocks, the company now also manufactures the Davis & Berryman line of Feed Water Heaters, Hot Water Generators and Power Pumps, having purchased this business from I. B. Davis & Son, the original manufacturers. In addition, Pratt & Cady have purchased a welded steel tubing business, and will continue manufacturing welded steel tubing and fabricating the same into parts used by manufacturers of bicycles, motorcycles, automobiles, vacuum cleaners, metal bedsteads, etc.

Chicago Pneumatic Tool Company Holds National Sales Conference

The Chicago Pneumatic Tool Company on January 21 and 22 held a general conference of executives, plant and branch managers and salesmen at its Detroit plant, Second avenue and Amsterdam street, on the occasion of the formal opening of a large five-story addition. At this conference the tremendous expansion programme of the company for 1920 was outlined, calling for largely increased production, not only at Detroit but at the five other American plants of the company. It was reported that much of the proposed increase in production was already absorbed by orders for future deliveries.

The nation-wide chain of service stations which the company has opened and supplied with complete stocks of spare parts, machinery and tools, and provided also with facilities for handling territorial repairs for users of the company's products, was also outlined in detail.

Gill Piston Rings

On account of the large amount of reboring and regrinding of scored cylinders which is being done to-day, a tremendous demand has developed for oversize piston rings to equip pistons for such jobs. The Gill Manufacturing Company, of Chicago, is specializing in over-size rings for this class of work, and makes no extra charge for special over-size rings. Gill Piston rings are made to fit practically all motors, in sizes ranging from 2 inches to 12 inches. Gill piston rings which are over-size on the diameter can be obtained through jobbing and accessory houses throughout the United States, or inquiries can be addressed to the factory and they will be referred to the nearest jobber.

An Interesting Calendar

The Badenhausen Company, of Philadelphia, has issued an interesting 1920 calendar and poster through its Scotch marine boiler manufacturing department. A copy of this calendar will be sent to anyone desiring it upon receipt of 7 cents in stamps to cover postage. The calendar is instructive, in that it shows various steps in the Scotch marine boiler manufacturing process at the company's modern boiler plant at Cornwells, Penn.

A. E. Saunders Joins International Mercantile Marine

Mr. Albert Ed. Saunders has recently resigned as technical assistant to the Chief Surveyor of the American Bureau of Shipping, 66 Beaver street, to accept the position of Naval Architect in the Construction Department of the International Mercantile Marine, 9 Broadway, New York City.

HEAVY ORDER FROM JAPAN

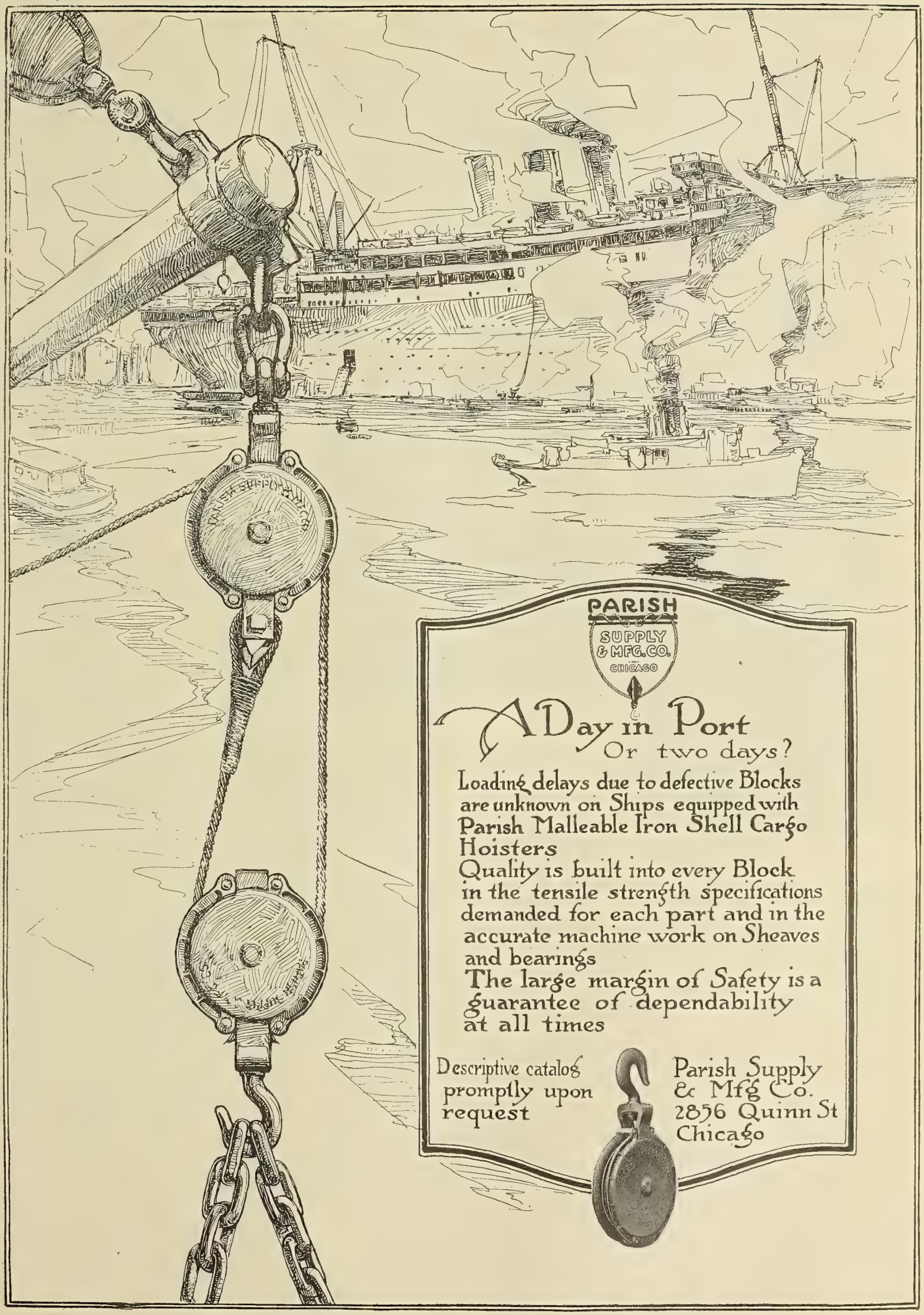
Electric Motor For Slabbing Mill to Be Supplied By Westinghouse Company

An order for the first steel mill electric motor ever built for a large reversing slabbing mill, with a complete set of accessory apparatus, has recently been placed in this country by the Imperial Steel Works of Japan. The apparatus will be furnished by the Westinghouse Electric & Manufacturing Company, and the order is the second for electrical steel mill equipment to be received by this company from the Imperial Steel Works. The equipment is to be used with a slabbing mill with which it is expected to roll steel ingots weighing up to 25 tons, down to slabs having a maximum dimension of 17 by 46 inches and a minimum of 4 by 20 inches.

The motor will be of the double unit reversing slabbing mill type, of 5,800 horsepower continuous capacity and 17,600 hosepower momentary. It will have a speed range of 47 to 90 revolutions per minute, and will use direct current at a voltage of 700. Power for the motor will be furnished by a motor-generator consisting of two 700-volt direct-current generators driven by one alternating-current motor. The generators each will be of 3,000-kilowatt capacity, and will operate at a speed of 368 revolutions per minute. They are to be connected in series with the reversing motor, and will be designed to stand the same momentary current peaks that it does. The motor which drives the two generators will be of the eight-pole, wound-rotor induction type, and will be of 6,250-horsepower capacity. It will take 3-phase, 25-cycle alternating-current power at 3,300 volts. A 150,000-pound cast steel flywheel is to be used with this set. It will be composed of three sections, and will measure 14 feet 9 inches in diameter. Control for both the reversing motor and the motor generator set will also be furnished.

Another part of the equipment will consist of a three-unit exciter set consisting of two direct-current generators driven by an alternating-current motor. One generator will be of the constant potential type and rated at 62 kilowatts, 250 volts. The other will be series wound, and rated at 37½ kilowatts, 0-250 volts. This motor will be of the squirrel cage, 3-phase induction type, and rated at 125 horsepower, 440 volts, 25 cycles. The speed of the set is 720 revolutions per minute.

Other apparatus will consist of a blower driven by a 50-horsepower, 440-volt, 3-phase, 25-cycle, squirrel cage induction motor, an air washer and a 165-kv-a, 3-phase, 25-cycle, 440-volt/3300-volt transformer for supplying the blower motor and exciter set. A pump for circulating water will also be supplied, driven by a 7½-horsepower, direct-current, 1,200 revolutions per minute, 230-volt shunt-wound motor, equipped with starter and start and stop push buttons.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A Day in Port
Or two days?
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CORY ANNIVERSARY

Marine Electrical Equipment House 75 Years Old and Growing

Charles Cory & Son, Inc., of 290 Hudson street, New York City, will celebrate their seventy-fifth anniversary this spring by moving into their modern, reinforced concrete and glass factory building, now nearing completion on the corner of King and Varick streets, New York City. The story of the Cory Company is an interesting one, having begun when steamships were scarce, and to commemorate its seventy-fifth anniversary a history of the institution is now in the course of preparation by J. S. Jones, engineer of the firm. Its publication is expected to appear about the time when the company will move into its new factory.

Charles Cory established the business in 1845, at which time it consisted of the manufacture and installation of brass railings for ships, ships' bells, bell pulls,

John M. Cory, President

voice tubing, etc. Later on, however, upon the advent of the mechanical engine telegraph, this company was the first in the country to manufacture this appliance, and has always been a pioneer in designing and manufacturing signaling equipments for ships.

Three generations of Corys have guided the course of the company since its inception, and it has constantly and consistently taken the lead in the development of marine requirements for electrical and mechanical signaling devices, as well as lighting equipments for the various navies and the merchant marine service.

John F. Cory, son of Charles Cory, managed the business from 1866 until 1892 During this period the firm started the manufacture and installation of electrical telegraphs and other electrical signaling apparatus for the navy and merchant marine. Charles Cory, 2d, grandson of the founder, was the third member of the family to assume charge of the business. His career of 22 years ended with his death in 1914.

John M. Cory, president and treasurer, and the second grandson of the founder, is largely responsible for the firm's more recent rapid growth. Due to his able administration as president and treasurer, and to the many inventions of marine electrical appliances by Frank W. Wood, vice-president, the Cory Company has achieved an enviable reputation, and is among the foremost and largest manufacturers of marine electrical equipment in the world to-day.

Visualizing the growth of Charles Cory & Son, Inc., in the past seventy-five

F. W. Wood, Vice-President

years will be facilitated by comparative figures. The business originally started in 1845 at 278 Division street, New York City, where they occupied a total area of 1,500 square feet. To-day, in their three factories at 286 Spring street, 290 Hudson street, and 487-489 Greenwich street, the floor space occupied is in excess of 70,000 square feet. The new building will contain more than 100,000 square feet, and be completely occupied by the Cory Company. The firm has further expanded during the administration of John M. Cory, until it now has branches in New York, Philadelphia, New Orleans, Seattle and San Francisco; also offices in Bath, Camden, Baltimore, Newport News, Portland, Long Beach, Cal., and Canada, as well as agencies in all the principal cities of the United States.

The Cory Company is known the world over. By means of its many branches and branch offices it is enabled to give services in every important seaport on both the Atlantic and Pacific Coasts, which is a valuable asset to the purchaser of its appliances.

Gielow & Orr Separate

Announcement is made that the partnership between Henry J. Gielow and Alexander M. Orr, naval architects and engineers, at 52 Broadway, has been terminated as of January 3. The business will be carried on by Henry J. Gielow at the same address.

CONCRETE SHIPYARD TO BE NAVAL BASE

Scofield Plant, San Diego, Cal., Given Up By Shipping Board

The Shipping Board has turned over to the Navy Department a lease on 500 acres of waterfront property in San Diego, Cal., now occupied by the concrete shipyards of the Scofield Engineering Company, according to a San Francisco announcement. The Navy will take possession of the property immediately after the launching of the 7,500-ton oil tankers *San Pascual* and *Cuyamaca* this spring. The yard will be converted into a fleet repair base, and will be able to drydock vessels up to 3,000 tons.

Rear-Admiral Roger Wells has been selected to take charge of the new base.

To Increase Zinc Oxide and Lithopone Production

The New Jersey Zinc Company announces the contemplated construction of additional zinc oxide and lithopone plants to meet the rapidly growing demand for these products. It is the aim of the company to keep pace with the growing requirements for these products by the construction of additional plants. The company plans to construct its plants at strategic geographical points, so as best to serve its customers in various parts of the country. Construction work will be commenced immediately on plants in Colorado and Pennsylvania. The company has already provided its ore supply for this increased production, and it aims to place itself as early as possible in a position to supply adequately the requirements of the important industries which it serves.

The New Jersey Zinc Company was organized in 1848, and is the oldest and largest zinc company in America. Its ore properties are located in various parts of the country, and include the famous Franklin, N. J., mine, from which is secured zinc ore unequaled for purity anywhere in the world. The company is now operating zinc oxide, lithopone and slab zinc plants in Pennsylvania, Virginia, Illinois, Wisconsin, Kansas and Oklahoma. Its products are carried in warehouses in Brooklyn, Newark, Philadelphia, Pittsburgh, Cleveland, Chicago, Los Angeles and San Francisco. Other warehouses will be established as required. Sales offices are maintained in Chicago, Ill., and Pittsburgh, Penn., and at its headquarters in New York City.

With the manufacturing plants now in operation and those to be constructed, the company will be in the best possible position to serve promptly and economically its trade throughout the country.

Sun Marine Oils

HAVE PROVED THEIR WORTH

QUALITY SERVICE

SUN OILS

RELIABILITY EFFICIENCY

Good Ships deserve Good Oils

Let our engineers solve
your engine room troubles

SUN COMPANY

1428 So. Penn Square - - - PHILADELPHIA, PA.

STOCKS CARRIED AT

New York City Boston Philadelphia Baltimore Pittsburgh Cincinnati Buffalo St. Louis
Chicago Minneapolis Toledo Newark Newport News Detroit Atlanta New Orleans Sabine

GETS PROFIT BOTH WAYS

Contractor Paid For Removing Hulls Finds Market For Them

Portland, Oregon., has furnished a shining example of how profits may be made in handling ships. The story is that George F. Rodgers, of George F. Rodgers & Company, of Astoria, has a contract with the Emergency Fleet Corporation by which he receives $5,000 each for disposing of the thirty-four unfinished wooden hulls remaining in shipyards as a result of the cancellation of contracts after the signing of the armistice.

Two of the hulls at the Grant Smith-Porter yards in Portland, and one at the Standifer Company's North Portland yard, have been sold by Mr. Rodgers to Captain W. Z. Haskins, of the Oregon Stevedoring Company, who will complete the hulls as soon as possible as five-masted schooners. Then he will operate them himself or sell them. They will have the latest equipment for the rapid handling of cargo, especially lumber.

In this case, Mr. Rodgers will receive $15,000 from the Government for ridding the shipyards of these hulls, plus the purchase price received from Captain Haskins. His only expenditure in this transaction is the cost of maintaining a small crew for a few days at the Grant Smith-Porter yard preparing the two hulls there for launching before he entered into negotiations for their sale.

Under Mr. Rodgers's present plan all the unfinished hulls on the ways in the United States are to be sold and completed, and none will be destroyed.

WORK OF SHIPPING BUREAU

2,234 Vessels of 5,790,729 Gross Tons Classified in 1919

At the annual meeting of the American Bureau of Shipping, at the head office, 66 Beaver street, this city, a few days ago, it was reported that for the year ending December 31, 1919, the records show the classification of 2,234 ships, of 5,790,729 gross tons, almost four times the tonnage of 1915.

There are at present building under Bureau supervision in this country a total of 3,656,336 gross tons, which includes all wood and steel ships being built by the Government and private ownership; this is approximately 85 per cent of all ships building in this country.

It was pointed out that upon the completion of the present programme the American Bureau of Shipping will have classified 20 percent of the world's total merchant fleet, which places it second in importance of all classification societies in the world.

Building Refrigerator Ships

Among the contracts which the Submarine Boat Corporation, 5 Nassau street, is putting through at the Newark Bay yards, is one for refrigerator ships for the International Products Company, 120 Broadway. Two of these, it is reported, are under way, and will be of 1,400 gross tons. They are to be ready in the late spring.

TO BUILD CONCRETE BOATS

Col. M. A. Butler Will Head New Concern at Norfolk, Va.

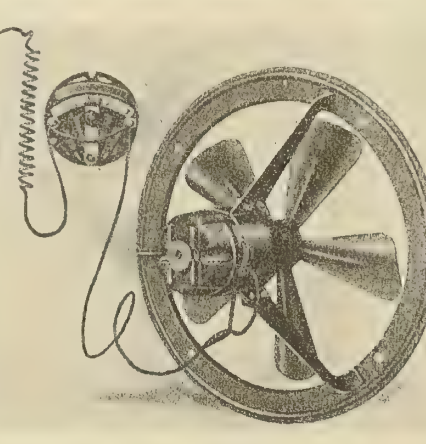
It has just been made public that Col. M. A. Butler, who has been in charge of the Army Base at Norfolk, Va., will be released from army service on March 15, and will assume the duties of president and general manager of the Norfolk Construction & Marine Repair Corporation, of Norfolk, which is to erect one of the most complete repair yards in that section, according to announcement, comprising three railways of 500, 1,200 and 3,000 tons, respectively, and ways and equipment for the construction of concrete barges and scows.

The plant is on the southern branch of the Elizabeth River, and consists of about 60 acres and has about a half mile of water front. This property was formerly owned by the National Concrete Boat Company.

The new concern has taken over the assets and holdings of the National Concrete Boat Company, and has a capital of $1,000,000. Its officers are: President and general manager, Col. M. A. Butler; vice-president, Robert D. Davis; chairman of the board, W. G. Schwartz; chief engineer, Arthur W. Deuel; directors, C. E. Herbert, J. A. Pretlow, W. Frank Robertson, Capt. C. S. Clark, S. E. Tillett, C. McI. Tunstall, S. H. Ellerson, Howard G. Avery, J. Murray Priest.

Ventilating Outfit

A fan having six speeds is being placed on the market by the Buffalo Forge Company, Buffalo, N. Y. It is claimed that the unit is economical in operation, with large capacity. The fan is



Six Speed Ventilating Fan

16 inches in diameter driven by an inclosed motor which will operate on a 110- or 220-volt, or a single-phase 25, 30, 40, 50 or 60 cycle alternating current circuit. The air capacity is 1,000 cubic feet per second, and the speed 500 to 1,000 revolutions per minute.

New York City Has National Safety Institute

A great forward drive toward the reduction of both industrial and public accidents in the Metropolitan district of New York has just been made through the appointment of R. S. Jarnagin, Regional Supervisor of Safety for the Eastern Railroads, United States Railroad Administration, as secretary of the New York Local Council of the National Safety Council and the Safety Institute of America. Headquarters of the New York local will be maintained in the office of the Safety Institute in the Arsenal building, Central Park. All the exhibits, the library and other facilities of the Institute will be placed at the disposal of the local council. The National Safety Council will send one of its field secretaries to New York to co-operate in the reorganization of the present local council of that city, along the lines of the local councils at St. Louis, Pittsburgh and Cleveland.

In view of the importance of the Metropolitan District as an industrial center this promises to be one of the most important councils yet organized. The New York local council will organize and conduct schools for safety supervisors and foremen, workmen's mass meetings, and conferences for industrial executives. The promotion of public safety, school safety and educational safety will be a distinct service of the Safety Institute, and will be carried on in the metropolitan district under the direction of the Institute, the National Safety Council co-operating.

The Safety Institute will soon be moved to the Arsenal building in Central Park. This building, which is being remodeled, will provide good accommodations for the various schools of the Council.

Selling Shipbuilders' Town

Dundalk, the town located near Sparrows Point, and including 531 modern homes for shipbuilders, which were built by the Emergency Fleet Corporation during the war for workers at the Bethlehem Shipbuilding Corporation, Ltd., plant, is to be sold. This is expected to give some relief to the Bethlehem's housing problem in Sparrows Point and Baltimore, as about half of these houses were vacant, as workers refused to rent them until they knew the terms of sale. The terms have been announced now, and the shipbuilders are to have the first preference.

To Build $4,000,000 Dock

The Dominion Government has completed the purchase of 750 feet of water frontage for a terminal site in Vancouver (B. C.) harbor. The property cost nearly a million dollars, and was bought from the Great Northern railway and the Weaver estate. The new pier to be erected this year will be just west of the Great Northern dock. The government dock with equipment, but not including site, will cost $4,400,000, it is announced.

DRILLS SQUARE HOLES

Fairbanks Company's Device a Commercial Success

The only device that will drill a square hole in one operation, in any metal or substance, out of the solid material, without previous preparation and without subsequent finishing, is the "Radbore Head." This attachment is merchandized by The Fairbanks Company, Broome and Lafayette streets, New York, and carries the well-known "Fairbanks O. K."

The "Radbore" is a square-hole drilling attachment, based on the well-known principle of the Cardan Circles, which can be easily and rapidly attached to any milling machine or drill press.

Reference to Fig. 2 will explain just how it is done. The figure 1-2-4 is a cross section of the shank of a drill which is rotated inside a square guide, as shown by the outside lines. If cutting edges are ground on the end of the drill, as indicated in Fig. 2, they will sweep across the surface of a square with rounded corners. Hence if the drill is fed into the material it will cut out a square hole with filleted corners. To make a hole with sharp corners, a shank, as indicated in Fig. 1, 1-2-3-4 is used. One cutting edge is longer than the rest, and this goes into the corners to square them.

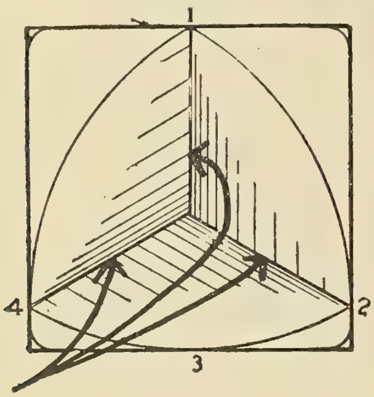


Fig. 1

Development has made this tool one of surprising simplicity, positive action and minimum wear. The drills have a positive drive from the spindle of the machine, and the cutting lips follow a path determined by the adjustable jaws of the head, so that no preliminary round hole is necessary. The cutters are so designed that there is no material in the bottom of the hole which is not removed by the cutting edges; therefore, blind square holes can be obtained in one operation and without any subsequent finishing.

One of the most important features of the "Radbore" is the design of the drills. The drills are manufactured in two different styles—for brevity called types "A" and "B." Type "A" derives a hole with filleted or rounded corners. This fillet is one-eighth (1/8) of the drill size; and the radius, or the amount of stock that is left in each of the four corners of the square hole, is absolutely equal. This assures an equal distribution of power where a square hole (and the square hole is admitted by all engineers to be the most perfect drive) is used, either in a drive gear or in a drive shaft. Further, as a radius is left in the four corners, there is no possibility of the power being applied except on the four sides of the square, owing to the fact that the drive shaft is always milled flat on the edges, and hence will not touch in the corners of the square. The measurement across the corners of any square hole drilled by a type "A" drill can be quickly determined by multiplying the drill size by the constant 1.311.

The type "B" drill is designed for die work, the squaring of the ends of key ways, etc., and the driving of square holes with sharp corners. In other words, the type "B" drill is a great asset in the tool room for the quick and accurate completion of sundry jobs, while the type "A" drill is of the greatest commercial value out in the factory—on production.

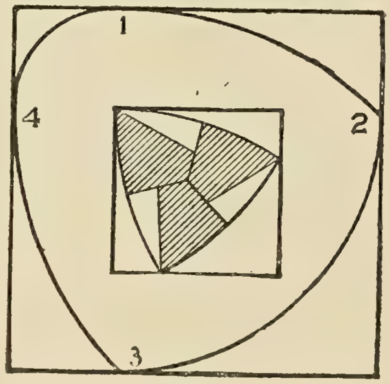


Fig. 2

The broach, being the first in the field, received much consideration and is now a production machine, although it carries the disadvantage of high maintenance cost, the possibility of mislead in the work; *i. e.*, the drilling of the round lead hole first.

The entire proposition of drilling square holes with the "Radbore" attachment has narrowed itself down to the ease and rapidity of round-hole drilling. Being a free cutting tool with sufficient chip clearance, a heavy pressure on the feed is unnecessary, and aluminum can be drilled as easily as the toughest steel—a perfect chip being thrown in either case. Additional advantages are those of obtaining a blind hole with a perfectly flat bottom; no chance of the drill being led off by sand or blow-holes; no previous preparation—the square hole being drilled from the solid; also, as the drills are sharpened on the end there is no loss in size resulting.

"Radbore" heads or chucks are manufactured in four sizes and two different styles—the range of drills, 1/8 inch to 2 inches, being as near equally divided between the four chucks as possible. Type "A" drills are manufactured from 1/8 to 2 inches by sixteenths, and the type "B" from 1/8 inch to 1 1/4 inches by sixteenths.

Numerous methods of machining and drilling square holes have been brought to public attention from time to time, and have generally been frowned upon by practical engineers and manufacturers with just cause. The general assumption concerning other tools producing square holes, especially those of the rotary type, is that they are too frail and will not stand up under quantity production. The "Radbore" has stood the test and has been a commercial machine for a number of years.

HEAVY STEEL CONTRACT

Barde Steel Products Company Buys From Shipping Board

The Barde Steel Products Company has been incorporated recently under the laws of the State of Delaware. Most of the directors are bankers from New York and the West. It has also been understood that this enterprise has been organized by M. Barde & Sons, steel, iron and machinery merchants of Portland, Ore. They have been in this line of business for the past twenty-five years, and are considered to be the largest iron merchants on the West Coast, and, of course, their names will also appear in the board of directors.

At the present time the corporation owns between 350,000 and 500,000 tons of steel, consisting of plates, shapes and bars of all descriptions, etc., which were recently purchased from the United States Shipping Board. The value of this contract runs up to about $30,000,000. It has also been stated that the same concern is negotiating for an additional large quantity of steel.

Mr. L. Baron, formerly manager of the engineering and chemical department of J. Aron & Company, Inc., was appointed general export manager of this new corporation. Mr. Baron has been recognized in the export business for the past fifteen years, and has traveled extensively over Europe, including Russia and the Orient, and has made very good connections in the foreign countries. All this, together with his technical training and the wide experience acquired, will, undoubtedly, enable him to sell a large portion of the material in question in the foreign markets, as he has a thorough knowledge of their demands.

Ship Upholstery Springs

Special springs have been produced for ship upholstery by Foster Brothers Manufacturing Company, Utica, N. Y. The filling of Foster upholstery consists of multiples of small springs made of high-grade carbon wire and specially tempered to produce long life. Springs are of the double cone type, knotted at both ends to prevent their working loose and into the padding. A metallic clip fastens them together securely so that the action of each spring is distributed over the entire system.

Finished cushions are available in sizes that are multiples of 3 inches, and with springs made of 14, 15 or 16 gage wire.


THE
AMERICAN SHIP BUILDING CO.,
CLEVELAND, OHIO
SHIP BUILDERS ENGINEERS
DRY DOCKING REPAIRS
SHIPS BUILT TO THE HIGHEST CLASS OF BRITISH LLOYDS AND THE AMERICAN BUREAU OF SHIPPING FOR DEEP SEA SERVICE . . . . .
—PLANTS AT—
CLEVELAND, OHIO DETROIT, MICH. BUFFALO, N. Y. WYANDOTTE, MICH.
LORAIN, OHIO MILWAUKEE, WIS.
SUPERIOR, WIS. CHICAGO, ILL.
COMBINED CAPACITY OVER 500,000 D. W. TONS YEARLY

CONVERT FERRIS HULLS

Four Ferris Type Boats to Be Changed to All-Steel Cargo Carriers

Through some skilfull handling of a difficult task by H. E. Ankener, naval architect, and L. C. Ripley, chief hull draftsman of the Terry Shipbuilding Corporation, of Savannah, the incomplete composite ships at the Terry yards at Port Wentworth, will now be converted into acceptable all-steel cargo carriers.

By the proposed change the deadweight tonnage of each vessel will be increased from 3,500 to 4,200 tons. The length will be increased forty-five feet, oil substituted for coal and a steel hull placed instead of the wooden one. Other changes are also to be effected.

It is said that the surveyors for the American Bureau of Shipping, 66 Beaver street, New York, declared that it was a great accomplishment to have solved such a difficult and long-tried problem so successfully, and that it was a wonderful improvement over the Ferris design. By making the proposed changes, the old composite ships can be not only utilized, but can be made very economical to operate, and will be vessels of the highest efficiency and classification.

EFFECTING BIG SAVINGS

Synchronous Motor More Economical Than Steam Engine

An excellent example of the superior economy of the synchronous motor as compared with the steam engine for driving ice machines, is the installation in the Manhattan street dairy of the Sheffield Farms Company, New York, where 80,000 quarts of milk are handled every day. This plant contains four 80-ton Newburg ammonia compressors and a 12-ton York compressor, which were driven by steam engines before the war. After America went to war, however, fuel was hard to get, its price rose rapidly, and the Government ordered all inefficient engine-driven ice plants to be closed down. The necessity of making some change in their drive was realized by the officials of the Sheffield Farms Company, so they decided to use an electric motor and obtain power from the local lighting company.

The present drive consists of a 500-horsepower Westinghouse synchronous motor, operating on a 440-volt, 60-cycle circuit, and which has a speed of 350 revolutions per minute. This motor is belted to a line shaft from which all of the compressors are driven, and, in addition, two 14 by 10-inch air compressors and two generators of 110 and 125 kilowatts, respectively, used for supplying current for local lighting. Current is supplied by the United Electric Light & Power Company.

While this installation, being originally planned for engine drive, is not arranged in an ideal manner, nevertheless the officials state that the efficiency of the motor is so much greater than that of the older drive that its savings and increase in capacity amount to $[illegible]0,000 a year.

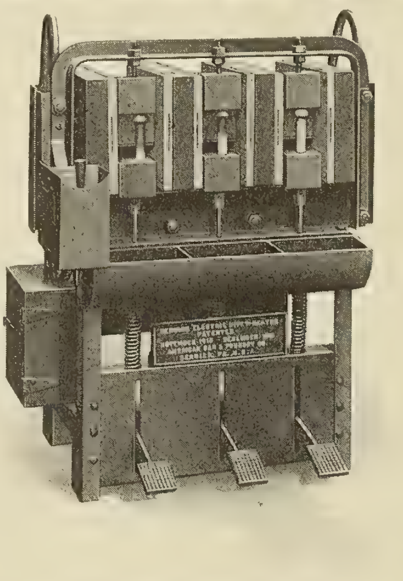
One of the interesting features of the installation, which is now recognized to be of great importance in ice plant management, is the careful attention given to the graphic meter chart, which shows the amount of power being used. Since the load is practically constant under given conditions, the curve drawn by the meter should ordinarily be a straight line. But any variation in the factors of production, such as the depreciation of any part of the machinery, a change in the temperature of the brine, water, etc., or the alteration of any other detail, at once changes the power demand, which is noted by the meter. An investigation is immediately made as to the cause of the variation, and correction is applied as soon as possible. Thus the efficiency of the plant is kept maximum at all times.

The use of a synchronous motor, instead of an induction motor for this installation, is in line with the present tendency in refrigerating engineering practice. The synchronous motor is favored because of its high efficiency, uniform speed, and ability to improve the power factor of the electrical system in the plant; and an ammonia compressor is well adapted to be driven by this type of motor, because, with the use of by-passes, the starting conditions are light and the speed is constant.

At the Sheffield Farms plant 110 tons of ice are produced daily from purified and filtered city water.

Electric Rivet Heater

The Berwick electric rivet heater, first built six years ago to improve their own shop conditions by the American Car & Foundry Company, 165 Broadway, New York City, has been greatly improved, being now built in ten types. It is simple, portable, absolutely safe and practically fool-proof. It gives a hot rivet in 30 seconds; heats 100 pounds of any size rivets in 20-kilowatt hours; the heating costs are reduced from 25 percent to 65 percent, and it reduces rivet loss to less than one-half of 1 percent; eliminates smoke, gas dirt and intense heat, and provides uniformity of heat, radiating from the center outward.



Berwick Electric Rivet Heater

It is built with one, three or five electrodes, the five-electrode heater having a capacity of over 450 an hour, if required. It heats rivets 5/8, 3/4, 7/8 and 1-inch diameter up to 4 1/2 inches long or longer.

NEW CONRADSON PLANT

Machine Tool Concern Includes Joseph T. Ryerson & Son

Announcement has recently been made of the incorporation of the Conradson Machine Tool Company, of Green Bay, Wis., of which Mr. C. M. Conradson is president. Mr. Conradson is well known in the machine tool field, at one time being associated with the Gisholt Machine Company, of Madison, Wis., and later being engaged in general consulting work in tool design.

The new concern is associated with Joseph T. Ryerson & Son, who will market the complete outfit of the new plant, consisting of plain and universal milling machines, selective head lathes, planers and radial drills. "Ryerson-Conradson" is the trade name under which these machine tools are being sold. The new line embodies radical departures from present designs of similar machines, and the new features aim to fill present-day heavy-duty production requirements.

Ground was broken for the Conradson Machine Tool Company plant in the spring of 1918. The building has recently been completed, equipment installed and production is now under way.

The initial unit of the proposed plan of buildings consists of machine shop and main erecting bay, both of saw-tooth construction, a power house and heating plant and office building. The erecting bay is served by a Pawling & Harnischfeger 10-ton crane. The machine shop equipment is modern in every respect, and consists chiefly of individual motor-driven machine tools. The equipment includes Ryerson-Conradson planers, radial drills, milling machines and selective head lathes; Brown & Sharpe and Hald grinders; Brown & Sharpe, Bilgram and Fellows gear cutting machines. The small tool equipment is especially complete, and includes Johannson gages and internal and external micrometers. The tool room equipment consists of the same modern type of tools, and is complete in every respect.

Joseph T. Ryerson & Son, the selling representatives, have been in business for more than seventy-five years, and during the past several years have been making large expansions in the machinery division of their business. They have steel and machinery warehouses at Chicago, St. Louis, Detroit, Buffalo and New York, with district offices in practically all of the larger cities, and maintain agents and direct representatives throughout the world.

BUSINESS NOTES

Barclay, Parsons & Knapp announce the change in the firm name to Parsons, Klapp, Brinckerhoff & Douglas, the personnel of the firm remaining unchanged.

Mr. George L. Washington, of the negotiation division of the Westinghouse Electric International Company, has left East Pittsburg for Cuba, where he will be located as salesman in the Havana office of the company.

The St. Louis sales office of the Standard Underground Cable Company, Mr. E. J. Pietzcker, manager, was on February 1 removed from the Security Building, where it has been located since 1897, to the Arcade building.

Mr. A. S. Winter, formerly connected as advertising and sales manager with The William Powell Company, has joined the sales force of The Fairbanks Company, Pittsburgh, Penn., and will represent them in Southern Ohio.

William F. Brady has resigned his position as superintendent of the boiler shop of the Edward Renneburg & Sons Company, Baltimore, Md., to become superintendent of the tank and stack department of the Erie City Iron Works, Erie, Pa.

Mr. J. F. Paige has been made operating manager of the Halifax (N. S.) Shipyards, Ltd., a subsidiary of the Canada Steamships Company. Mr. Paige was formerly with the Port Arthur (Ontario) Shipbuilding Company as general manager.

Mr. Irving H. Jones, who is well known in machine tool circles in the Chicago field, has become associated with the machinery department of Joseph T. Ryerson & Son, and will specialize in sales engineering work on the Ryerson line of machine tool equipment.

Mr. I. F. Baker, of the Westinghouse Electric International Company, who has been located in the New York office of that company for the past two years, is on his way to Tokio, Japan, where he will act as a special representative of the Westinghouse International Company.

It has recently been announced that "A. W. P." electrodes, produced by the Alloy Welding Processes, Ltd., 14-16 Cockspur street, London, S. W. 1, have been approved by Lloyd's Register of Shipping and by the British Corporation for the Survey and Registry of Shipping.

H. A. Lacerda, for some time past connected with the boiler inspection departments of the Federal Shipbuilding Company, Kearney, N. J., and the Morse Dry Dock & Repair Company, Brooklyn, N. Y., has assumed his former connections with the Erie Railroad in the shops at Jersey City, N. J.

Mr. Arthur Elliot Allen has been appointed district manager at New York for the Westinghouse Electric & Manufacturing Company, to succeed Mr. Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Company.

Frederick William Renshaw, president of the Globe Seamless Steel Tubes Company, Chicago, Ill., died February 1 of pneumonia at his home in Evanston, Ill. Mr. Renshaw was born in Chicago, February 26, 1880. He was a graduate of Harvard Preparatory School and Sheffield Scientific School.

Mr. William R. Gummere, who for a number of years represented the Independent Pneumatic Tool Company in Cleveland, Ohio, has again become affiliated with that company. Mr. Gummere will be connected with the Pittsburgh branch, which is under the management of Harry F. Finney.

Mr. John T. Dillon, president of the Titusville Forge Company, Titusville, Penn., formerly Titusville plant of the Bethlehem Steel Company, has announced the opening of a Pittsburgh sales office in charge of Mr. C. W. Forcier, 433 Union Arcade, Pittsburgh, Pa., and their New York office in charge of Atkinson & Utech, Inc., 111 Broadway, New York City.

In order to obtain closer co-operation between the factory and sales department, the Electrolabs Company announces the consolidation of all offices at 2635 Penn avenue, Pittsburgh, Pa. The request is issued by the company that all future correspondence be addressed to the Pittsburgh office. A branch office will be maintained at Room 313, 30 Church street, New York City.

The College of Engineering of the University of Illinois, Urbana-Champaign, announces the appointment to its staff of instructors of Matthew Riddell, Jesse Benjamin Kommers, Floyd Hamilton Fish, Elmer Newman Bunting, Roswell Miller Rennie, Oscar William Schricker, Louise Marie Woodroofe, Ezra Edward Bauer, Clarence Carl Schmidt, Ralph Douglas Doner and Enoch G. Bourne, since the beginning of the academic year in September.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Penn., has announced the appointment of Alexander Taylor, for many years manager of works, as assistant to the vice-president, to have general charge of production, stocks and stores. R. L. Wilson has been promoted from the position of general superintendent to works manager of the East Pittsburgh plant. E. R. Norris has been appointed director of works equipment, in charge of machinery, tools and methods in the various plants.

The following appointments of sales representatives have been made by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio: New York, Charles Hubbard & Company, 81 Fulton street; Chicago, Warren Corning & Company, Transportation building; St. Louis, Certes Supply Company, 'Frisco building; Atlanta, Spalding & Small, 1010 Hurt building; Philadelphia, Read - Rittenhouse Company, 1234 Commercial Trust building; San Francisco, Berger-Carter Company, Tenth and Mission streets; Seattle, A. M. Castle & Company of Washington; Boston, Austin & Doten, 102 North street.

Edward D. Kilburn, who since March 15, 1917, has been New York district manager of the Westinghouse Electric & Manufacturing Company, was recently elected vice-president and general manager of the Westinghouse Electric International Company. Maurice Coster, who has for more than thirty years handled the foreign interests of the Westinghouse Company, continues as vice-president of the International Company. The president of the International Company is Loyall A. Osborne, who is senior vice-president of the Electric Company, and was actively engaged in national work during the war.

When the Manufacturers' Aircraft Association holds its second annual Aeronautical Exposition at the Seventy-first Regiment Armory, Thirty-fourth street and Park Avenue, New York, in March, 1920, the public will have an opportunity to see what American designers have accomplished in developing commercial airplanes—planes for private use, for sporting or touring purposes, or long-distance transportation of freight and mail. The larger planes have a carrying capacity of from three to six thousand pounds, and, driven by three or four motors, will cover half the distance across the United States in a single flight. The cost of operating airplanes has been reduced during the last year from the almost prohibitive figure of one or two dollars a mile, until now it compares favorably with motor trucks and railroads.

The Champion Rivet Company, Cleveland, Ohio, announces the appointment of George W. Denyven, of Boston, as New England agent. Mr. Denyven has been identified with the iron and steel industry in its various branches for many years. His first experience in boiler work was obtained with Edward Kendall & Sons, Cambridge, Mass. Later, in South Africa, he was employed as a boiler maker and inspector by the Central South Africa Railroad. For a few years he traveled through Australia, New Zealand, Honolulu, and then to San Francisco, where he located in the boiler shops of the Santa Fe Railroad. At different periods he has been connected with the Pacific Hardware & Steel Company; A. C. Harvey Company, Boston, Mass., and during recent years with E. P. Sanderson Company, Cambridge, Mass., whom he will continue to represent in connection with the Parkesburg Iron Company, Parkesburg, Pa.; Rome Iron Mills, New York; The Pollak Steel Company, Cincinnati, Ohio; The Locomotive Firebox Company, Chicago, Ill., and the Champion Rivet Company. The Boston offices are at 141 Milk street.

OBITUARY

Joseph M. Flannery

Joseph M. Flannery, president of the Standard Chemical Company, died a few days ago at his home, 149 North Dithridge street, Pittsburgh, Penn. Mr. Flannery had been in poor health for many months. He was a lifelong resident of Pittsburgh, born there July 18, 1867.

He had been instrumental in the organization of a number of enterprises, among which were the Meadow Lands Coal Company, the Flannery Bolt Company, the American Vanadium Company, the Standard Chemical Company, and the Rosanoff Process Company.

To Mr. Flannery is due the introduction of vanadium in the steel industry, marking an epoch in steel making. Convinced of the value of vanadium for this purpose, he went to South America, where he secured the world's largest vanadium deposit. Through his interest in vanadium, Mr. Flannery's attention was called to an ore occurring in Colorado which contained radium.

Having heard of the possible use of radium in the treatment of cancer, he determined to undertake the production of radium. In 1911 he organized the Standard Chemical Company, and this pioneer company is to-day the world's largest producer of radium. Mr. Flannery leaves his widow, Mollie Gearing Flannery, one daughter, Miss Helen K.; three sons, Joseph M., Jr., John and Raymond, and one brother, J. J. Flannery.

Harold McGill Davis

Harold McGill Davis was born in Jerseyville, Ill., on August 26, 1860, the son of Samuel W. and Mary J. McGill Davis. His early boyhood was spent in Kansas, where his father was treasurer of the town of Paola, to which he was elected thirteen consecutive years. Harry, as he was called by his friends, had a public school education, finishing in the St. Louis High School, after which he became office boy in a lead and oil factory. While in high school a cadet corps was organized, and afterward mustered into the 2d Regiment of the National Guards of Missouri. He became a second lieutenant, and was a member of a picked squad which gave exhibition drills and fancy evolutions. Leaving the lead and oil company he was appointed chief clerk of the St. Louis United States Assay Office by President Chester A. Arthur. Finding a government position too slow and uncertain, he came to New York to study architecture. Being active in church work he was elected president of the Brooklyn Christian Endeavor Union in 1901, and the next year was chairman of the printing committee in connection with the Christian Endeavor Convention held in Madison Square Garden. The financial panic of 1893 offered him a chance to get into the advertising profession, and for four years he was advertising manager of a trade paper in New York. Then he joined an advertising agency, thus fitting him for the position of manager of the advertising department of the Sprague Electric Works of the General Electric Company, which he obtained in December, 1899.

His ability as a writer and designer gave him an advantage over other solicitors which publishers were quick to recognize, and resulted in the formation in leading publishing plants of what is now known as the Service Department. Aside from his advertising he frequently contributed to papers poems, both religious and humorous, and descriptive articles.

Albert Schmid

In the death of Albert Schmid, which occurred in New York on December 31, 1919, the engineering world has suffered a great loss. Mr. Schmid was not only closely identified with the early development of electrical machinery in the United States, but was also prominent in the electrical world of France, Switzerland, Italy and Great Britain. Mr. Schmid was born in Zurich, Switzerland, in 1857, and received his education in that city. He began his real career by entering the employ of the French Westinghouse Air Brake Company. Coming to America, Mr. Schmid turned his attention to design work for the Westinghouse Air Brake Company, then located at Allegheny, Penn., later becoming chief designer for the Union Switch & Signal Company. In 1886 he was transferred to the Westinghouse Electric Company as chief engineer, and in 1896 became its general superintendent. On the formation of the French Westinghouse Company he was made director general of that organization. He had also held the positions of director of the Westinghouse Electric Company, Ltd., of England, president of the Compagnie des Lampes à Filament Metallique, of France, and at the time of his death, in addition to being consulting engineer for the American Westinghouse Company, he represented the Westinghouse Lamp Company and had general supervision of its interests abroad.

Evarts Shankin Barnum

Evarts Shankin Barnum, of the G. M. Basford Company, 30 Church street, New York City, died at his home in Ridgewood, N. J., on February 3, after an illness of eight days. Mr. Barnum was born in Louisville, Ky., in 1883, and received his education at Purdue University, graduating in 1906. Immediately upon his graduation he entered the service of the Pennsylvania Lines West as apprentice, and worked successively as apprentice, machinist, foreman, general foreman, roundhouse foreman and motive power inspector. Leaving the railroad in 1917 he joined the staff of the *Railway Age* as associate editor, and later later became associated with the G. M. Basford Company, in charge of the copy department.

Mr. Barnum endeared himself to all with whom he came in contact. His even and pleasing disposition, and his desire to "help the other fellow," made a friend of everyone he met. He is survived by his wife and two children.

Frederick Holbrook

News of the death in Paris of Frederick Holbrook, vice-president of the American International Shipbuilding Corporation, and builder of the Hog Island yard, has been received. He had been ill only a short time, having left New York last December to visit Russia in the interests of the Grace-American International Corporation, of which he became president at its formation last year, to do business in Russia. In 1916 he went to Russia in the interests of the American International Shipbuilding Corporation, soon after becoming vice-president, and remained a year. During 1918 he had charge of Hog Island as president of the corporation. He was president of the Holbrook, Cabot & Rollins Corporation, of Boston, which constructed buildings, railroads and drydocks in the United States and Mexico. Mr. Holbrook was born in Lynn., Mass., 59 years ago.

Edmund Mills

Edmund Mills, engineer in the marine department of The Babcock & Wilcox Company, died January 26, 1920. Mr. Mills was born in Jersey City, N. J., February 15, 1864. He was educated in the public schools of Jersey City, served an apprenticeship as a machinist and worked a short time at that trade. He was in business for himself a short time, and later was with an electric corporation.

Somewhat more than twenty-five years ago he entered the marine department of the Babcock & Wilcox Company as a draftsman, and continued in that department all the rest of his life. He was chief draftsman of the marine department for a number of years, and about twelve years ago was transferred to the marine department of the general office as one of its engineers. He had educated himself so that he was an expert on the production and use of steam, and was an engineer of unusually fine mechanical judgment. He was very much interested in the subject of Arctic exploration, and had collected a library of Arctic literature which is probably one of the best possessed by any individual. He was also an amateur astronomer.

He was a man of very attractive personality, high integrity and absolute loyalty. By his death The Babcock & Wilcox Company has lost one of its oldest and most efficient employees, and his associates a friend whom it will be hard to replace.

Mr. Mills was a member of the Society of Mechanical Engineers, Society of Naval Architects and Marine Engineers, and the American Society of Naval Engineers. He leaves a wife and a son, who is also an engineer.

HELP AND SITUATION AND FOR SALE

☞ ***No advertisement accepted unless cash accompanies the order.***

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Naval Architect and Marine Engineer open for an engagement, wide experience abroad and in this country on all classes of marine construction. Address *Architect,* care of MARINE ENGINEERING.

Hull Draftsman, having ten years' experience on new working plans for battleships, torpedo boats, oil tankers, passenger and freight steamers, desires position with some reliable shipbuilding firm. References furnished. Address *Box* 123, care of MARINE ENGINEERING.

Position Wanted as Purchasing Agent—Seventeen years' shipyard, railroad and manufacturing experience. Stores and shop systematizer. New construction and repairs. References furnished. Address *Box* 48, care of MARINE ENGINEERING.

A Mechanical Engineer, who has made a specialty of fire and watertube boiler construction, who is an up-to-date boiler shop executive, is open for engagement as Superintendent or General Foreman on boiler and steel plate construction. Address *Box* 37, care of MARINE ENGINEERING.

Are You Getting Best Welding Results?—Experienced welding engineer, acetylene, electric arc and spot; good hull and sheet metal draftsman, desires permanent position. Held executive position in Emergency Fleet Corporation; age 32; best references. Address *Box* 362, care of MARINE ENGINEERING.

Designing Draftsman, with electrical, steam engine, turbine or special machine experience, wanted for permanent position with large manufacturing concern in New England. Applicant give age, experience, education and salary expected. Address *Chief Draftsman, Box* 50, care of MARINE ENGINEERING.

Naval Lietuenant, with nine years' practical operating experience in engineering department of vessels with various types of installations, desires position as Chief Engineer of ocean steamer or yacht. Licensed as unlimited chief; 32 years of age; unmarried. Will consider $4,000 salary. Expect to be released June 1. Correspondence invited. Address *Chief Engineer,* care of MARINE ENGINEERING.

A Southern Shipyard wants a man of wide experience, ashore and afloat, to act as Superintending Engineer in charge of shop and mechanical equipment and installation of marine engines and boilers. He must hold unlimited chief's papers and act as trial chief. In answering, give complete data of work for past fifteen years. Replies confidential. Address *Box SE-*8, care of MARINE ENGINEERING.

Marine Draftsman—Large shipyard in vicinity of New York has openings for the following men: Turbine Designer, preferably man with experience in designing Parsons turbines; Marine Steam Engine Designer; Engine, Pipe and Electrical Draftsman; technical graduates preferred. Positions permanent, with excellent opportunities for advancement. Address *Box* 798, care of MARINE ENGINEERING.

GOVERNMENT PLACES

The United States Civil Service Commission announces competitive examinations on March 16, 1920, for PETROLEUM ENGINEER, $3,000 to $4,500 a year, and ASSISTANT PETROLEUM ENGINEER, at $2,100 to $3,000 a year. Vacancies in the Bureau of Mines, Department of the Interior, for duty in Washington, D. C., or in the field, at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion. The entrance salary, within the range stated, will depend upon the qualifications of the appointee and the importance of the duty to which assigned. Applicants should at once apply for Form 2118, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.; the Secretary of the United States Civil Service Board at any place where there is a Civil Service office.

On March 17, 1920, there will be an examination for AUTOMATIC SCALE EXPERT. A vacancy in the Customs Service, New Orleans, La., at $1,600 a year, and vacancies in positions requiring similar qualifications throughout the United States, at this or higher or lower salaries, will be filled from this examination. Applicants should at once apply for Form 1312, stating the title of the examination desired, to the Civil Service Commision, Washington, D. C., or to the secretary of the United States Civil Service Board at any place where there is a Civil Service office.

On March 23, 1920, extminations will be held for FOREMAN, HEAT TREATMENT OF ARMOR PLATE, $10 to $14.40 a day, and FOREMAN, HEAT TREATMENT OF LARGE GUNS, $8 to $12.56 a day. Vacancies at the U. S. Naval Ordnance Plant, South Charleston, W. Va., at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion. Certification to fill the higher-salaried positions will be made from those attaining the highest average percentages in the examinations. As difficulty has been experienced in securing eligibles for these positions, qualified persons are urged to enter these examinations. For these positions at the Naval Ordnance Plant male eligibles are desired. Applicants should at once apply for Form 1371, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C., or to the secretary of the United States Civil Service Board at any place where there is a Civil Service office.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 428 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 808 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—A. H. Haag, 127 Woodside Ave., Narberth, Pa.
Vice-President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Secretary—B. G. Barnes, 6 Meadow Way, Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; E. H. Monroe, Washington, D. C.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS
National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottstown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Can.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

General News and Technical Notes

$3,000,000 ADDITION TO SUN SHIPBUILDING COMPANY'S PLANT

Big Drydock, With Wet Dock, Ways and Shops, To Be Built at Chester, Pa., Plant

The Sun Shipbuilding Company announced a few days ago that it is to construct a 600-foot drydock at its plant in Chester, Pa. The dock will be of the graving type, the only one of its kind on the Delaware River, and will cost with other improvements planned about $3,000,000. A wet dock 600 feet by 200 feet, and capable of handling three ships, will also be built, as will three additional ways, of which the company at present has six. The company has two wet docks now able to handle six ships at the same time. Only work on the outside of the ship below the waterline has to be done in a drydock, and the vessel can then be transferred to a wet dock for other repairs. The company plans to build several additional shops in connection with the drydock, and will also make an addition to its general office building.

Work on the new projects will start within thirty days, and it is expected it will be completed before the beginning of next winter.

John G. Pew, president of the company, says: "The improvements will cost about $3,000,000, and we will be able to build ships up to 20,000 tons on the new ways. Ships on the present ways range from 10,500 to 12,000 tons." He adds that the Sun Shipbuilding Company is the only concern interested in the improvements. The Sun Company, an allied oil corporation, has a fleet of ten tankers and several barges, and Mr. Pew says that, from the Sun Company and allied organizations and privately owned vessels, there will be plenty of work for the new plant for an indefinite period after the proposed additions are completed.

TO TRY DIESEL ENGINES

American-Hawaiian Orders Two 11,000-Ton Freighters

One of the most interesting shipbuilding contracts recently placed is one by the American-Hawaiian Steamship Company, 8 Bridge street, New York, for two 11,000-ton shelter-deck freighters, to be built by the Merchant Shipbuilding Corporation, at its Chester, Pa., yards and equipped with Burmeister & Wain Diesel engines, built by the William Cramp & Son Ship & Engine Building Company, of Philadelphia, which has the commission to build the Scandinavian company's engines in this country. The freighters are to have a speed of about 11 knots.

The decision of the American-Hawaiian Company to try out the Diesel engines has caused much comment in American shipping circles, for reports from abroad say that the Diesels can be operated much more cheaply than steamers with either reciprocating or turbine engines.

Big Contract for Tankers

The Merchant Shipbuilding Corporation, Harriman, Pa., it is announced, has taken a contract for the construction of six steel tankers, each of 12,000 tons rating, to cost about $11,250,000 total. This order assures the yard of continuous operation for about one year after the completion of Government contracts, or until October, 1921. The company has also secured contracts for six additional vessels to be built at its Chester works.

ORDERS FOUR TANKERS

Union Oil Company, of Delaware, to Have Big Ships

Four modern steel tankers, which total 46,000 deadweight tons capacity, have been contracted for by the Union Oil Company, 120 Broadway, New York. Two of 12,500 tons each—85,000 barrels capacity—are to be delivered in March, 1921, by the Sun Shipbuilding Company, Chester, Pa. Two of 10,500 tons each—75,000 barrels capacity—have been contracted for through W. A. Harriman & Company, Inc., 165 Broadway, New York, to be delivered in November and December, 1920, by the Merchant Shipbuilding Corporation, Chester, Pa. Each of the 12,500-ton vessels will be equipped to carry about 3,500 tons of package cargo on return voyages.

These contracts place the Union Oil Company of Delaware well up in the list of the large oil companies which have tankers building or under contract in American shipyards. Planning tankers for carrying return cargoes to this extent is a development of an idea which has until now only been tried on a smaller scale.

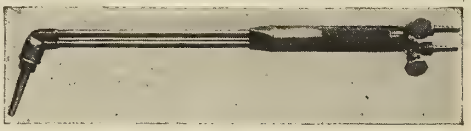
Planning a "Seagoing Fair"

The Export and Import Board of Trade management of Baltimore is considering a trade-boosting scheme of floating a "seagoing fair," equipping a vessel with Baltimore products and sending it on an extended cruise. A force of exhibitors would accompany the ship and boost Baltimore and her export and import facilities.

New Welding Torch

A welding torch, having various refinements of design, has recently been produced by the Air Reduction Sales Company, 120 Broadway, New York city. It is claimed that this torch increases the efficiency of the welding flame, although effecting the maximum economy in gas consumption.

The general design has been improved particularly in the construction of the



New Type Welding Tank

valve handles and hose connections. For convenience the gas pressure table has been rolled on the upper part of the handle. The valve handles are octagonal, and arranged on the left side of the torch where they will not catch in the operator's clothes.

The tubes are of hard-drawn seamless brass, countersunk at both ends, while the valve body and the butt of the handle are combined in a single casting instead of being screwed together as is the usual practice. Threads on the tip have been eliminated by the use of a tip nut to prevent gas leakage. Heads and tips of various types, available for use with the different sizes of torches, make the equipment adaptable to all classes of welding from sheet metal to castings.

Radiant Company Has New Advertising Manager

The Radiant Manufacturing Company, of Sandusky, Ohio, whose output the last two years has been entirely taken by a small number of large jobbers, will soon inaugurate a vigorous advertising campaign to dealers and farmers—a liberal appropriation having been set side for this purpose. Mr. A. H. Ambrose, for the past eight years assistant advertising and sales promotion manager for the Associated Manufacturers' Company of Waterloo, Iowa, has been secured as manager of the campaign. He is the one responsible for the sales work which made the "Jerry-Boy" hand-car engines so indispensable to section foremen all over the country, and has had wide experience in the manufacture and sale of farm lighting plants.

Mr. Ambrose states that the Radiant is the only complete single unit lighting plant on the market selling for less than $400 with batteries, and expresses his confidence in the 1920 sales being trebled over 1919 production.

MACHINE TOOLS SATISFY

Factory Managers Write To Government Officials

The director of sales of the War Department announces two successful sales of machine tools recently concluded between the Government and the La Fayette Motors Company, of Indianapolis, Ind., and the Austin Manufacturing Company, of Harvey, Ill. In a letter to Mr. Guy Hutchinson, first assistant director of sales, Mr. D. C. Selheimer, factory manager for the La Fayette Motors Company, says:

"We are glad to inform you that we have this date completed negotiations with the Cleveland office in the matter of securing the two Natco Multiple Drills, Nos. 154 and 156. Our certified check for $5,450, together with shipping instructions, is being forwarded this date to the Cleveland office, and we trust there will be no unnecessary delay in making shipment. All previous machines purchased from the Government have been received in good condition. We wish to take this opportunity to thank you for all past favors to us in the matter of securing machinery, and to assure you that we fully appreciate your efforts."

The two Natco Multiple Drills referred to were purchased from the Ordnance Salvage Board through the district office at Cleveland. The other machines to which reference is made consisted of 41 machine tools, mostly lathes and milling machines, which were purchased from the Air Service, the price paid being $36,394.

Mr. W. G. Morse, factory manager for the Austin Manufacturing Company, speaks of the satisfactory service rendered by the Government in a letter to the office of the Director of Sales. He says:

"This will acknowledge your letter of December 24, which I have delayed a long time in answering. You will be interested in knowing how we came out in our purchase of machine tools, and I am pleased to advise that in all cases all of the machinery purchased was received here in first-class condition, properly packed and properly slushed, and I wish to thank yourself and the other men whom I met in connection with this proposition for the interest and courtesy which they displayed in all of our dealings."

Pensacola Dock Progressing

The third pontoon of the floating dock being built for the Bruce Dry Dock Company, Pensacola, Fla., was successfully launched on February 7. Indicators on the pontoon showed no measurable deflection during the launching. It is believed that the construction of this pontoon establishes a world's record, it being built and launched 39 days and 6 hours from the time of laying the first timber. This floating dock is of the Crandall longitudinally-trussed sectional type.

The dock is being constructed by the Aberthaw Construction Company, under the supervision of Paul H. MacNeil, resident engineer for The Crandall Engineering Company, Dry Dock Engineers, East Boston, Mass.

WESTINGHOUSE IN HAVANA

J. W. White, Electrical Engineer, in Charge of Cuban Office

The Westinghouse Electric International Company have opened a new office in the Royal Bank of Canada building, Aguiar and Obrapia streets, in Havana, Cuba. This was found necessary because of the growing use in sugar mills and other enterprises in Cuba of Westinghouse electric equipment. To form a closer relation with existing installations, and to be of the fullest service wherever knowledge, training and skill can be useful in electrification, will be the object of the force in the new office.

Mr. J. W. White, who has been located in Cuba for some time past as Westinghouse representative, will be in charge of the new office. Mr. White's intimate knowledge of and close relation with the industries in Cuba peculiarly fits him to cope with all the problems that may be encountered. He will be ably assisted by other special engineers, and this, with the convenient location of the new office, will give to the many customers, friends, and to others interested in any form of electric development, a confidence which emanates from a first-hand knowledge of the good qualities and reliability of Westinghouse apparatus.

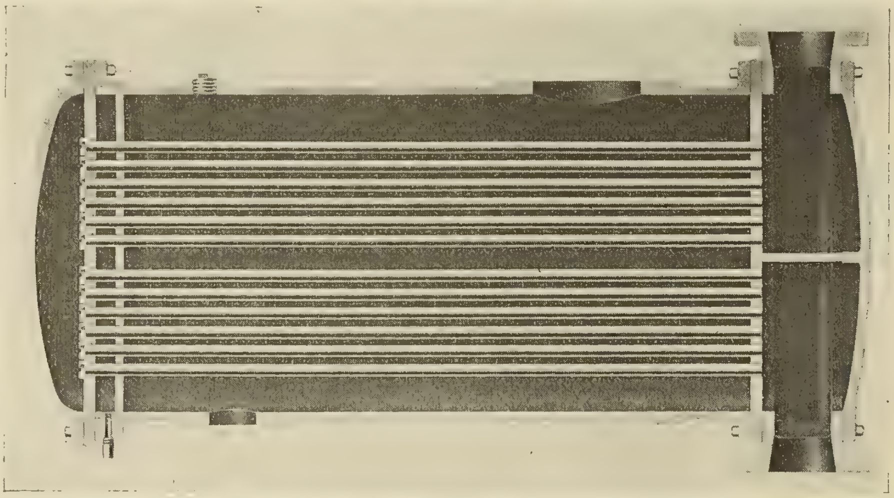
A complete stock of catalogues and other descriptive matter will be maintained in the new office, where for the asking can be obtained complete information on everything electric, from an electric iron or fan to the powerful steam turbine generators or electric locomotives.

National Marine Week Exposition, Grand Central Palace, Lexington avenue and Forty-sixth street, New York, April 12-17, 1920

New Wheeler Condenser

It was recently brought up at a meeting of marine engineers that most of the ships now in service are experiencing trouble with leaky condensers. These leaks have been almost invariably traced to the stuffing box between the tube and the tube plate. It has been found that in spite of the kind of packing used some leakage is practically unavoidable, due to the expansion and contraction of the tubes with temperature changes.

The illustration herewith shows a new type of condenser developed by S. Morris Lillie. This condenser is used chiefly in connection with salt circulating water on board ship, or in regions where the water used for circulating purposes would be bad for boiler feed in case of leakage into the condenser and the consequent mingling of the bad water with the condensate.



New Wheeler Condenser

The tubes are tightly expanded into the right-hand tube plate, in order to eliminate the possibility of leakage at this end. At the other end the tubes are provided with the standard ferrules and condenser packings. At the left end of this condenser a thin auxiliary tube plate or baffle is provided, through which all of the tubes are passed. The holes in this plate are of such size as to make a sliding fit with the tubes. It is obviously not necessary that these joints be absolutely watertight.

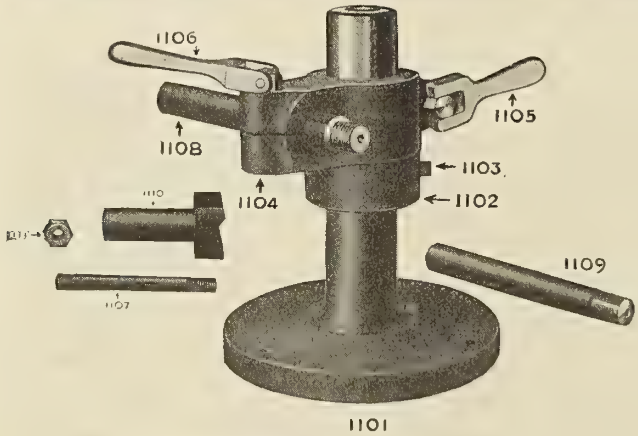
In case of leakage of circulating water through the ferrules and packing, such leakage immediately drops down to the bottom of the compartment between the two tube plates, and is then carried off by the drain shown at the bottom, to which is attached either a small direct-acting condensate pump, or a vacuum trap, depending upon conditions.

We are advised by the manufacturers, The Wheeler Condenser & Engineering Company, Carteret, N. J., that all sizes of this condenser (known as Type 3) are now available at a cost but slightly in advance of standard types.

Assembling and Repairing Pneumatic Tools

An entirely new device for facilitating the handling of pneumatic tools while they are being assembled or repaired has been produced by the Independent Pneumatic Tool Company, Chicago, Ill.

The device is called the "Universal Assembling and Repair Vise," and consists of a flanged upright machine post or stand, having a sliding stop collar which will quickly adjust the device to the proper height for convenient working. Directly over the collar is a clamp swiveling on it. The collar may be held in any



Universal Assembling and Repair Vise

position by tightening a quick-action clamp screw. At the other end of the clamp is a hole in which stems having ½-inch and ¾-inch pipe threads are engaged. For small size drills ⅛-inch pipe threads are used in connection with the stem support.

In operating the device, the sliding collar is first adjusted to the desired height and the proper size stem support required for the drill to be repaired is inserted. If a large drill is to be repaired it is screwed in place at the dead-hand hold, but if work is being done on drills of small size the top clamp screw must first be tightened, then the stem inserted in the support and a nut screwed on the short threaded end of the stem. This allows the long end of the stem to project through the support. The small drill may then be screwed on the stem at the dead-hand hold until it is tight against the formed square head of the stem support. The drill is then ready for repair.

When the top clamp screw is released it is possible to turn the drill in any desired position for inspection, reaming, lapping piston holes, removing the gear case, spindle, valve gear, connecting-up rods or adjusting, by a simple pull of the side clamp screw lever.

Record of De Laval Reduction Gears

The De Laval Steam Turbine Company, Trenton, N. J., reports that over one hundred De Laval marine reduction gears, ranging in capacity from 750 to 13,500 horsepower, are now in actual service and are reported to be very successful in operation. A number of these have been installed on vessels which have run over 100,000 miles. Not a single case of trouble has been reported. The action of the reduction gears is characterized by quiet operation, high efficiency and absence of wear.

CORDAGE FIRM GROWING

Whitlock Company To Have More Room and Power

The Whitlock Cordage Company, of Jersey City, N. J., has completed building plans involving an expenditure of more than $250,000. Contracts have been let to the John W. Ferguson Company, of Paterson, N. J., which include the erection of a four-story reinforced concrete building, an additional story to Building No. 9, and an addition to the power house.

The new building, which will measure 100 by 100 feet, is to be used for manufacturing purposes, and will accommodate 80 additional employees. The floors will be of maple, and the stairways of reinforced concrete. Provision for a lunch-room has been made on the third floor.

The additional story to Building No. 9 will be of heavy mill construction, and is planned to be 90 feet wide, 130 feet long and 15 feet high. The additional bay to the power house, measuring 20 feet wide, 54 feet long and 30 feet high, will be walled with brick, floored with brick and concrete, and reinforced with wood supported by steel trusses. Four new boilers, of 400-horsepower each, are to replace the present boilers of 200-horsepower capacity, and a new 500-kilowatt and another 1,000-kilowatt turbine are to be added to the engine room.

Sweden Needs Tankers

A report from Hamburg, Germany, says that Sweden is in need of tankers. A subsidy has been granted by the Commercial College of Stockholm, covering about two-thirds of the cost of two 6,000-ton steamers to be built, but these steamers will carry only one-third of the annual oil requirement of the country. The subsidy is 8,000,000 kroner.

How the "Gun" Tap Works

The Greenfield Tap & Die Corporation, Greenfield, Mass., has adopted a tap designed on the principle that a shearing or slicing cutting stroke embodies advantages not usually found in a tap.

In Fig. 1 it will be noticed that the cutting edges *A* at the point of the tap

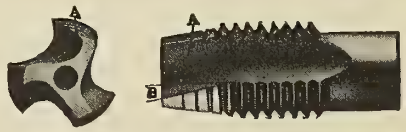


Fig. 1

are ground at an angle *B* with an axis for a distance of three or four threads. This angle, in conjunction with the hook of the land and special flute form, produces a long, curling chip, Fig. 2, similar to that a well ground lathe tool turns

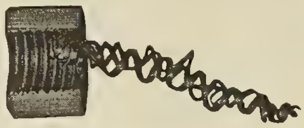


Fig. 2

up. As the tap progresses the chip is passed out ahead, from which fact the name "Gun" tap has been applied to the tool.

The flutes not being required for the passage of chips are particularly small, so that a large cross sectional area remains, giving the tap additional strength, Fig. 3. All of the cutting is done by the first few teeth, the rest of

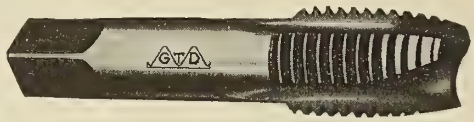


Fig. 3

the thread acting as a lead screw to steady the tap.

It is claimed that the new tap shears the metal instead of tearing it, making possible accurate work on a production basis, and requiring only about half the time to drive it that the ordinary tap does.

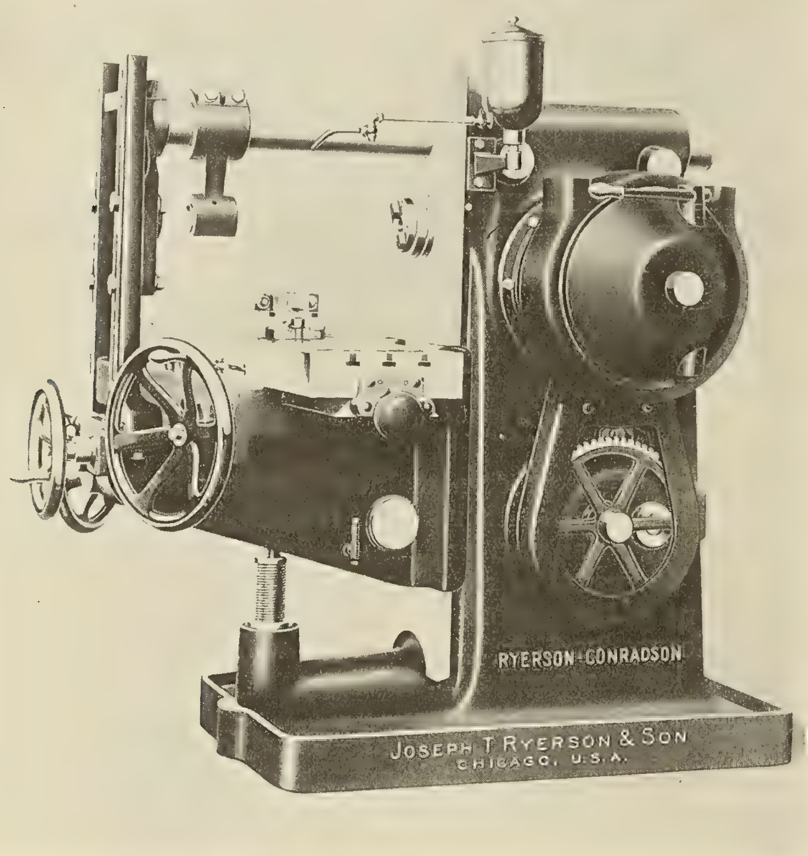
New Crandall Dock for Baltimore

The Globe Shipbuilding & Dry Dock Company, Fairfield, Baltimore, Md., are to have at their new repair plant a 9,000-ton floating dock of the latest design. This dock is of the longitudinally-trussed sectional type designed and developed by The Crandall Engineering Company, Dry Dock Engineers, Boston, Mass. It measures 440 feet over the keel blocks, and 83 feet between the wing walls. The pumping is accomplished by 24 electrically-operated centrifugal pumps, the control of which is so centralized with indicators that the dockmaster may readily govern the pumping in all the compartments of the dock.

High Power Milling Machines

The first machine to be produced by the Ryerson-Conradson Company, the output of which is controlled by Joseph T. Ryerson & Son, Chicago, Ill., is the No. 3 Ryerson-Conradson High Power Milling Machine.

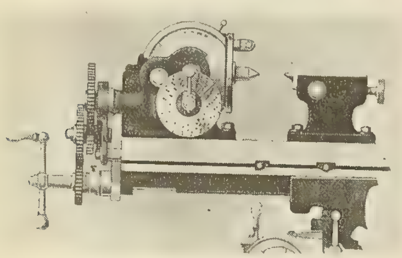
It is claimed that the new machine has highly increased power, rigidity and



Ryerson High Power Milling Machine, No. 3

convenience of operation, and is adapted to light and heavy manufacturing and jobbing work.

One feature of the design lies in the application of the helical drive, which tends to longer life and steadier operation of the milling cutter. The speed range required by the commercial mill-

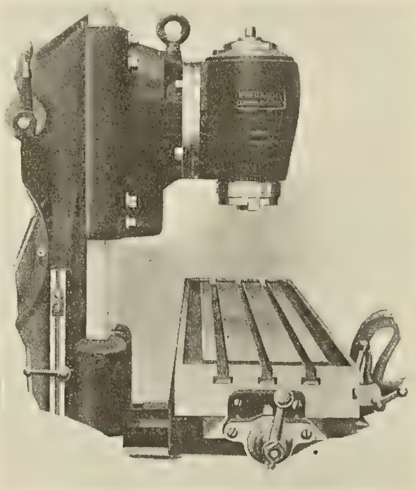


Universal Dividing Head

ing machine has been maintained in the new design. The column is a rigid casting, ribbed internally, and cast integral with the base. A deep flange is turned around the base to stiffen it and to act as an oil retainer. The face of the column is extended above the overarm, which affords a firm support for special fixtures.

The knee is massive and deep, absorbing the vibration when heavy cuts are taken. The bearing surface between the knee and the column is greatly increased by extending the back of the knee up to a point nearly level with the top of the table.

To avoid all binding action when raising or lowering the table, an elevating screw is located at the center of gravity and is made telescopic. Both the table and saddle have large bearing surfaces. Special consideration has been given to the design and construction of the spin-



Semi-Universal Milling Attachment

dle, spindle drive, feed drive, safety devices and feed screw adjustment.

The No. 3 Milling Machines are driven at a constant speed of 600 revolutions per minute, and require from 5 to 7½ horsepower. The gears run immersed in oil and are completely enclosed, so that they are dust-proof and practically noiseless. As the driving pulley is also enclosed, the machine conforms to all safety requirements of the Workmen's Compensation Laws.

Thrust is taken up by S. K. F. bronze bushed ball bearings, while the change gears are cut from solid chrome nickel steel, and are heat treated.

The Universal Dividing Head has been designed to meet the requirements of the modern shop practice. It is especially rigid and provided with an extra large worm wheel meshing with a worm journaled in large bearings. Regular equipment consists of three index plates that divide all numbers to 50 and many beyond; wrenches, bolts, driving dog and index table giving all divisions up to 360.

A Vertical Milling Attachment of the semi-universal type has been designed to fit the milling machine, and is made in three sizes—light, medium and heavy pattern. The base is clamped to the column dovetail, no dependence being placed on the overarm. The heavy pattern type has the same diameter spindle and the same size bronze bearings as the main spindle. The taper hole face plate and driving keys are also the same, permitting as heavy a cut to be taken as on the horizontal spindle. The drive is effected by an aluminum bronze gear bolted to the face plate of the main spindle and driven by the cross key. In return, it engages a steel gear on a horizontal shaft, driving a vertical spindle through a set of bevel gears. This allows the spindle to be set at any angle parallel to the face of the column.

Page Steel and Wire Acquired by American Chain

The American Chain Company, Inc., of Bridgeport, Conn., has purchased the control of the Page Steel and Wire Company, with mills at Monessen, Pa., and Adrian, Michigan. It is the intention of the American Chain Company to continue the business of the Page Steel and Wire Company as heretofore, taking only its surplus product. The Page Company's plants consist of open hearth furnaces, rolling mills, wire mills, as well as fence factories.

The new officers elected under the reorganization of the company are: Walter B. Lashar, president; William T. Morris, vice-president; Wilmot F. Wheeler, treasurer; John E. Carr, assistant treasurer and William M. Wheeler, secretary. E. C. Sattley, general manager of the Page Company, will continue in that capacity, with offices in Pittsburgh, Pa. The American Chain Company has its general sales offices in the Grand Central Terminal Building, New York City, and district sales offices in Chicago, Boston, Philadelphia, San Francisco, Portland and Pittsburgh.

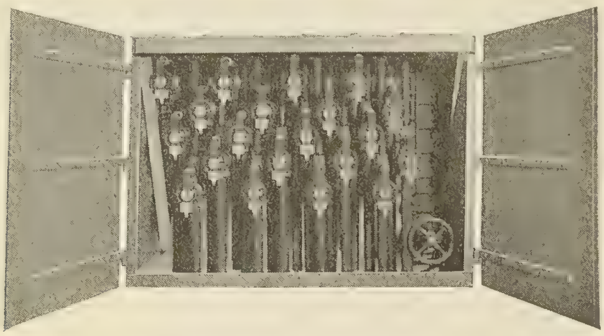
Detecting and Extinguishing Marine Fires

The fire menace from spontaneous combustion is very great in the inaccessible nooks and corners of storage spaces in the average ship. Detection of incipient fires is almost impossible because of this, and even when discovered it is difficult to get at a fire to extinguish it.

The Rich System for detecting and extinguishing marine fires operates on a combination of the two functions necessary to prevent conflagrations on ships at sea. In other words, it is designed to detect a fire by drawing samples of air to a central point in the wheelhouse from every danger spot in the ship, and to extinguish such a fire by drenching it with live steam.

When operating in its detecting capacity, should the air drawn to the cabinet contain the slightest trace of smoke, it may be detected, both visibly and by the sense of smell, by the officer in charge.

In detail, the Rich System comprises a system of single pipe lines radiating from a central point in the wheelhouse to every hold and cargo compartment in the ship. The pipes, which terminate in a detecting cabinet, are banked together in the smallest possible space, and the pipe ends are flared in order to make the sight of smoke more evident. The cabinet also contains a duplicate set of motor-driven exhausters which operate alternately while the system is working. By extinguishing the air from the cabinet, air samples are constantly brought to the cabinet from every closed space in the ship. Should the smallest fire start in any one of the holds, smoke appears at the mouth of the pipe connected to the hold in question.

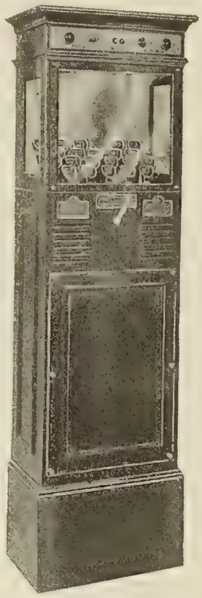


Steam-Regulating Valve Cabinet

When operating as an extinguisher, the pipes used for detecting the fire are also utilized for carrying the steam to put it out. A cabinet in the engine room or on deck, through which all pipes pass before going to the wheelhouse, contains the valves which control the admission of steam to the holds. When in operation, these valves cut off the pipe lines to the detecting cabinet, and, at the same time, admit high pressure steam to the pipes leading to the compartment on fire. Valves are, of course, numbered to correspond with each hold.

The original system is many years old, and has, in fact, been used for some time on the *Leviathan, Imperator, Mauretania, Aquitania,* and in ships of the Barber and Cunard lines.

The Rich System has recently been developed and perfected by Walter Kidde & Co., Inc., engineers and constructors, New York City. In its improved form, it is being installed in a number of new and reconditioned ships both by Government and private owners in this country, including the New York Shipbuilding Corporation, Camden, N. J.; the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., and the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.



Detecting Cabinet

Special Library Census

At a time when the Government is counting up its inhabitants, the Special Libraries Association is enumerating the special library collections of the country, because there does not exist at present an adequate directory of special libraries. In the spirit of co-operation, and in order to enlist the special information sources of the country, the Special Libraries Association—the national body of special librarians—submits the following questions and respectfully asks you to answer them. When compiled, the directory will not be used as a mailing list for advertisers, but merely for the purpose stated, to have in a central place a record of the special information sources of the country.

If your library comes within the above qualifications, the S. L. A. will appreciate the following information from you: (1) Name of institution or company. (2) Name by which library is known. (3) Name of librarian or custodian. (4) Can it be classified as any of the following: financial; business; legal; engineering or technical; institutional; municipal; reference; agricultural? (5) If not, how can it be classified? (6) Does it serve a special clientele? (7) Would your librarian be wiling to assist other special libraries to a reasonable extent?

The above data should be sent to William F. Jacob, Chairman Library Census Committee, care General Electric Company, Schenectady, N. Y., who will be glad to answer any questions relating thereto.

More Zinc Used in Government Paints

Standard paint specifications, under which the Government is recommended hereafter to purchase paints for use of the Army, Navy and other departments, have been determined upon by the Inter Departmental Committee for the Standardization of Paint Specifications.

Two features are significant: First, the importance of zinc oxide in increasing proportions is recognized by paint technologists on the committee; second, the latitude afforded by the specifications permits a large field of paint manufacturers to compete for Government business. The pigment proportions of the specifications follow:

	Minimum Percentage	Maximum Percentage
Zinc oxide	30	55
Lead (total, including either one or mixture of carbonate and sulphate)	45	70
Inerts and colors	0	15

The purpose of these specifications to provide for the purchase of prepared paints generally advisable in any section of the country, without requiring paint manufacturers to make up special batches. It is believed these specifications will include the formulæ of the majority of high grade paints on the market.

Of particular interest to paint manufacturers and users is the high proportion of zinc oxide introduced into the Government formula. This is regarded as one of the most sweeping official acknowledgments of this pigment's utility in paint yet recorded. Less than ten years ago, except in the Navy and the lighthouse service, no zinc oxide was included in paints used by the Government. It now composes 60 percent of the pigment of battleship gray paint that covers battleships and other U. S. Naval craft. The Capitol dome is covered with paint containing zinc, so that rust may be deterred; army cantonments are clothed with zinc paint, both inside and out, and during the war zinc paint aided in camouflaging the big field guns in France, as well as transports and battleships.

Recognition of zinc's efficiency has been a factor in the greatly increased popularity of ready-mixed paints. The durability of such paints makes their use economical, and they possess other advantageous qualities that commend them to users.

National Marine Week stands for American Independence on the Sea.
Where Do You Stand?

MAKING SEA TRAVEL SAFE

Steward Equipment to Be Shown at Marine Exposition

With the introduction of water-tight compartments in ships some years ago, it was thought that sea travel had been made absolutely safe, and the auxiliary life-saving equipment, lifeboats and the means of launching them quickly and safely, was neglected. And then—the Titanic struck an iceberg and foundered. Even her meagre and wholly insufficient lifeboats could not be launched in time, and a thousand persons perished. Immediately, most countries put into effect laws to compel ships to carry sufficient lifeboats, but a quick and safe method of launching them could not be legislated into being. Inventors began to work on the problem, and recently the submarine peril added further stimulus to their efforts.

Of special interest, then, as showing the progress which has been made, is the announcement received from the Steward Davit & Equipment Corporation, that they will exhibit their life-saving equipment at the coming National Marine Exposition, at the Grand Central Palace, New York City, April 12-17. This company has produced many noteworthy devices for reducing the risk in launching life-boats at sea, some of which are:

The Steward Mechanical Davit, for moving the lifeboat out-board, with the greatest possible speed, and with minimum confusion and expenditure of effort.

The Steward Lifeboat Falls Controller, a device recently introduced, which has as its object elimination of confusion and risk incidental to lowering away. With it, the lowering is controlled by one man, and lowering on other than an even keel is rendered impossible. It also permits of using a simple falls which cannot become tangled. This is a much needed device, as in lowering away many accidents have occurred.

The Steward Lifeboat Releasing Device, by which one man in the stern of the lifeboat is able to release both falls simultaneously, and at the most favorable moment. The action is positive under all possible conditions.

The Steward Lifeboat Roller Carriage, for aiding the lifeboat to run smoothly down the side of a listed ship. This carriage is also provided with powerful springs to distribute shock when the lifeboat is swung against a rolling ship, and prevent its being smashed. As an addition to safer lifeboat launching equipment, this is of great importance.

The lifeboat itself has not been neglected, and the Steward "Deadrise" type has many features to recommend it. It is nearly rectangular in section, and built with fewer plates than the old type. Its makers claim for it lower center of gravity and greater stability, less chance of leakage and greater capacity. It is being widely adopted. Even that standard piece of equipment, the line throwing gun, has had its share of attention; the Steward gun is so designed that the center of recoil comes well within the base, and the gun will not throw itself backward when fired.

Taken all together, the Steward equipment seems to be admirably designed for its worthy purpose—the saving of lives at sea, by substituting for the uncertain human factor, wherever possible, an unfailing mechanical device.

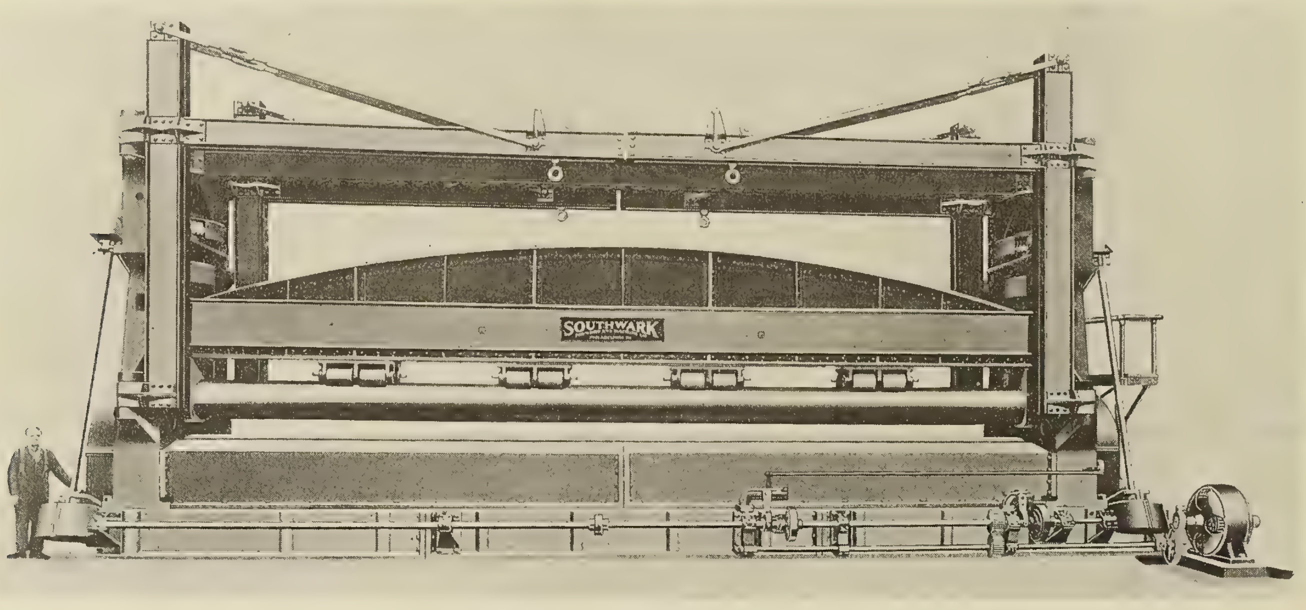
The Steward Davit & Equipment Corporation, 17 Battery Place, has asked us to extend through our columns a cordial invitation to all of our readers to visit them at the exposition.

National Marine Week stands for American Independence on the Sea.
Where Do You Stand?

World's Largest Plate Bending Roll

What is believed to be the largest plate bending roll in the world is now being installed by the United States Government at Mare Island Navy Yard, California. The machine was designed and built by the Southwark Foundry & Machine Company, Philadelphia, Pa.

The machine is of strong back construction of heavy proportions. The forged steel rolls are mounted in cast steel housings of box type construction. The roll housings are mounted on a heavy cast iron sub-base, while the top roll is supported at four points between the bearings by steady bearing rollers. These rollers are carried by a heavy arch beam, constructed of rolled steel sections. The strong back girder is fitted into the crosshead, both crossheads being hung on a swivel, so that the top roll may be thrown out of parallel. Steel gears with cut teeth are fitted throughout, and all bearings are bronze bushed.



Largest Plate Bending Roll in the World

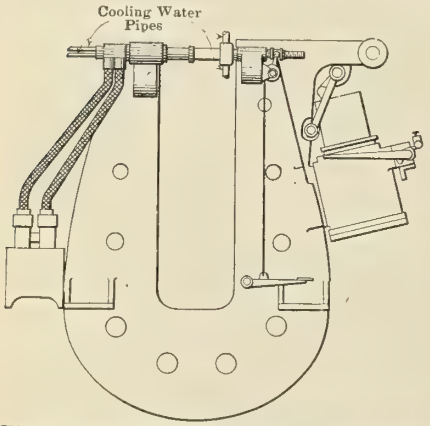
Four jib cranes, two at each side, with trolleys and eyes ready for attaching hoists, are provided for handling the work. The screw-down is operated by a separate motor of 50-horsepower, assuring accuracy and simplicity of mechanism. The rolls are driven by a 150-horsepower motor operating at a speed of 575 revolutions per minute.

The machine was designed to handle what are undoubtedly the largest plates ever rolled. It has a capacity for bending 37 feet of 1¼-inch plate. The machine measures 37 feet between housings. The top roll is 20 inches in diameter, and the lower rolls are 18 inches in diameter. The total weight of the machine with motors is 495,000 pounds. Nine cars were required to convey the knocked down machine from Philadelphia to Mare Island.

Electric Rivet-Heating Attachment for Bull-Riveting Machine

An electrical rivet-heating device, intended for use on gap, bull and hydraulic riveting machines, has recently been placed on the market by the United States Electric Company, New London, Conn. The attachment is arranged so that a hot rivet is left in front of the plunger at all times during the riveting operation.

Rivets are placed in their holes cold and the work to be riveted is moved so that it comes in contact with the electrodes automatically or by the motion of the plunger operated by a hand lever. The electrodes are so constructed that the rivets may be heated at once by bringing one rivet to the proper heat while the others are being pre-heated.



Electric Rivet Heating Attachment Applied to "Hanna" Riveter

Ordinary equipments are built to heat rivets of ½ inch to 1¼ inches diameter, but special machines may be built for larger diameters.

All sizes are available for use with alternating currents of 110 or 220 volts.

Mono Corporation Formed

The Mono Corporation of America, 48 Coal and Iron Exchange, Buffalo, N. Y., announces that it has purchased the entire stock of the Mono apparatus and accessories from the F. D. Hager Company, Buffalo, N. Y. This includes all rights for the manufacture and sale of the various types of Mono apparatus for the automatic analysis of CO_2, CO, O_2, H_2, SO_2, CI, etc.

It is to be noted that Mr. F. D. Hager, M. E., has not severed his connection, but will serve as general manager of the new corporation. Under his management all users of gas who have need of analysis and recording apparatus can depend upon prompt and careful attention to orders and inquiries.

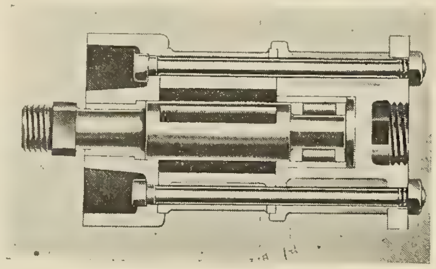
A service and inspection department, connected with the laboratory, is now in operation, and a competent chemical engineer in charge. Careful erectors will be placed at the disposal of customers in connection with the erection of new work, and regular inspection trips will be arranged to visit existing installations with a view to bringing about closer co-operation between the customer and the corporation. Mr. Hager, through the newly organized corporation, assures all of his friends and users of Mono apparatus generally that they can safely put their problems up to the corporation and consult them on such matters as chemical combustion of fuels and process work.

Efficiency in Boiler Tube Cleaning

Too much importance cannot be given the matter of tube cleaning in obtaining a high efficiency of boiler operation. There are various ways of cleaning tubes, but mechanical cleaners have been particularly useful in accomplishing satisfactory results.

Various cleaners produced by the Roto Company of Hartford, Conn., include air, steam and water-drive types. It is claimed that with the type A.D., having a positive balanced motor which replaces the usual water turbine drive, a set of tubes may be cleaned in a much shorter time than formerly required, at the same time eliminating any chance of injury to the tubes. Where an air compressor is available to supply the driving force, operating costs may be cut considerably. When steam is used, little inconvenience is experienced except in confined spaces.

The cleaners are equipped with positive-acting rotary engines. The cylinder bore of the engine, across which a single balanced blade fits in all positions, is not of the circular form ordinarily used in rotary engines. A single blade is used instead of the double or split type blade to reduce wear and friction, as well as to obtain a better balance. The driving force of the motor is similar to that of a piston engine, but turns it over at nearly the speed of a turbine. In the case of the Roto cleaners, the motors are balanced, double-acting and self-starting.


Sectional View of Motor

Hardened steel rings keep the casing straight, up to size and a correct fit for the boiler tubes after long service. These protecting rings prevent the cutters from wedging or sticking in the tubes and the consequent wearing to a taper form or becoming undersized, and so failing to function properly.

BUSINESS AND PERSONAL NOTES

The Consolidated Utilities Corporation, 730 South Michigan avenue, Chicago, has taken over the distribution of the Matthews full automatic electric light and power plants for country homes, which are manufactured at Sandusky, Ohio. Three models are made in marine styles, with rubber jar batteries, suitable for launches, cruisers, houseboats and barges. No water tank is furnished with these, but a suitable pump is supplied for circulating cooling water from outside the hull of the boat.

The Vulcan Iron Works, Inc., Jersey City, N. J., announces that Mr. George M. Ogle, formerly chief electrical engineer of the United States Shipping Board Emergency Fleet Corporation, is now a member of their engineering organization, in charge of the electrical contracting and consulting engineering department.

The Plant Engineering and Equipment Company, Inc., of New York City, manufacturers of the well-known Corliss Valve Steam Traps, Mason Condensation Meters and other power and heating specialties, announces the opening of its twenty-sixth office to care for the increasing demands for its products. Mr. M. William Ehrlich, experienced in consulting and contracting engineering, will be the New Jersey manager in charge, with headquarters at Newark, N. J., and a sub-office at Lyndhurst, N. J.

The Penn Seaboard Steel Corporation and the Admiral Anchor Company have removed their New York offices from 111 Broadway to 2 Rector street.

The Marine Corporation, Alaska Building, Seattle, Wash., announces that it is prepared to negotiate the purchase and sale of marine securities, making a special feature of certificates of ownership in merchant ships in commission. Correspondence on all matters relating to marine investments is invited.

In answer to an inquiry, the International General Electric Company, Schenectady, N. Y., announces that it has not taken over any American interests in the Franco Tosi Company, of Milan, Italy. The company, however, has contractual relations with Franco Tosi, S. A., whereby the latter acts as the representative of the former in Italy.

The Lidgerwood Manufacturing Company will have an interesting exhibit at the National Marine Exposition to be held in the Grand Central Palace, New York, April 12-17. They will exhibit two types of their standard reverse valve cargo winches. They have installed a compressed air outfit, to make an actual demonstration both of the hoisting ability of these winches and the extreme simplicity of control. The exhibit is at Booth No. 43, and is-

in charge of Mr. Ed. J. Boynton, who has had sea experience, was employed in the Lidgerwood works supervising the construction of their winches, and is now a member of their selling and engineering force.

The death, on January 27, of Mr. Pierregrant Bigelow, treasurer of the Bigelow Company, 149 Broadway, is announced by the company.

At a recent meeting of the stockholders of the Buffalo Forge Company, Buffalo, N. Y., new officers were appointed as follows: Henry W. Wendt, president; Edgar F. Wendt, vice-president and treasurer; C. A. Booth, vice-president and sales manager. The new directors include the above named officers and Mr. H. S. Whiting.

The Wheeler Condenser & Engineering Company, Carteret, N. J., announce the publication of the 1920 edition of their "Steam Tables for Condenser Work." This is the fifth edition of these tables. The pressures below atmospheric have been especially calculated for this book by Professor Marks. The book gives the properties of saturated steam from 29.8-inch vacuum to atmospheric pressure in increments of tenths of an inch. The vacuum in inches of mercury is referred to a 30-inch barometer. This method is of course superior to the old method of giving absolute pressures in pounds per square inch, since it is customary to read vacuum in inches of mercury. A complete table of the properties of saturated steam above atmospheric pressure is also included. The book indicates how to make measurements by means of the mercury column and barometer. It gives the contents and tables for making corrections, including those for the relative expansion of the mercury and the brass scale. It is a very handy book, and of a size that can be carried around in the vest pocket.

The Admiral Anchor Company, Penn Seaboard Steel Corporation, and Tacony Steel Company will have Booth No. 30 at the National Marine Exposition, Grand Central Palace, New York, April 12-17. A feature of their exhibit will be an Admiral Anchor.

Mr. Percifor Frazer announces his connection with the Merchant Shipbuilding Corporation, 1202 Finance Building, Philadelphia, Pa., where he is prepared to meet inquiries for vessels of any description and tonnage.

D. J. Flynn, open hearth superintendent of the Tacony Steel Company, has been transferred to the New Castle plant of the Penn Seaboard Steel Corporation, with which the Tacony Steel Compan recently merged. Mr. Flynn has had wide experience in the melting of the highest grade of alloy steels.

Mr. Morris Legori, for the last two years manager in Argentina for Vielé, Blackwell & Buck of New York, as manager of the firm's newly created foreign department, has joined Ray D. Lillibridge, Inc., 111 Broadway, New York, export advertising counsellors.

TRADE PUBLICATIONS

Chains—The Columbus & McKinnon Chain Company, Columbus, Ohio. 20 pages, illustrated. 5 by 8.

Marine Equipment, Catalogue 19. Stevens-Alysworth Company, Inc., 253 Broadway, New York. 24 pages, illustrated. 6 by 9.

The Answer to the Question of Labor and Production. duPont Chemical Company, Wilmington, Del. 28 pages. 8½ by 4.

Stratton, Jr., Oil Separator—Bulletin 1120. The Griscom-Russell Company, 2124 West Street Building, New York. 12 pages, illustrated. 6 by 9.

Hauck Burners for Foundries, Boiler, Machine and Repair Shops. Bulletin 112. Hauck Manufacturing Company, 111 11th Street, Brooklyn, N. Y. 16 pages, illustrated. 6 by 9.

Grinnell Company Bulletin—General Fire Extinguisher Company, 277 West Exchange Street, Providence, R. I. 16 pages, illustrated. 8 by 10½.

Brown Pyrometers—Catalogue No. 12, published by the Brown Instrument Company, Philadelphia, Pa. 88 pages illustrated. 8 by 10.

Durable Wire Rope—Issued by the Durable Wire Rope Company, 93 Pearl Street, Boston, Mass. 38 pages, illustrated. 3½ by 6¼.

Condensing Apparatus—Published by the Worthington Pump & Machinery Corporation, 115 Broadway, New York. 116 pages, illustrated. 6 by 9.

Catalogue of Valves, Hydrants, Steam Traps, Asbestos-Packed Cocks. The Pratt & Cady Company, Hartford, Conn. 192 pages, illustrated. 4¼ by 7.

Grinder Book No. 26—Columbia Manufacturing Company, Belleville, Ill. Covers grinders and buffers, grinding shafts and pressors for the heavy mill supply and automobile trade.

Ashton Pop Safety and Relief Valves, Pressure and Vacuum Gages, Locomotive and Power Plant Specialties. The Ashton Valve Company, Boston, Mass. Cloth bound. 176 pages, illustrated. 6¼ by 9¼.

1920 **Wall Map Calendar**—The Metal & Thermit Corporation, 120 Broadway, New York. Shows railroad time zones in the United States and Canada; also shows illustrations of Thermit welding jobs as applied to stern frames, rail, special welding and locomotive frame repairs.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS
National President—John H. Pruett, 423 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 808 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN
President—A. H. Haag, 127 Woodside Ave., Narberth, Pa.
Vice-President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Secretary—B. G. Barnes, 6 Meadow Way, Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; E. H. Monroe, Washington, D. C.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS
National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottstown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Can.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

MARINE ENGINEERING

May be Purchased at the Following News Stands

Eastern Hotel News Stand, Whitehall and South streets, New York.

Produce Exchange, Beaver street, New York.

News Stand, 11 Broadway, New York.

Whitehall Building News Stand, 17 Battery Place, New York.

Old Corner Book Store, 27-29 Bromfield street, Boston, Mass.

J. Gardner, 18 Broughton street, East, Savannah, Ga.

Staub News Depot, 735 Common street, New Orleans, La.

L. T. Taylor, 2215 Orleans street, Baltimore, Md., representative in Baltimore and Sparrows Point.

Foster & Orear, Ferry Building, San Francisco, Cal.

Archway Bookstore, Third and Pike streets, Seattle, Wash.

Lowman & Hanford Co., First ave. and Cherry street, Seattle, Wash.

HELP AND SITUATION AND FOR SALE

No advertisement accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Business Manager of Repair Yard, twelve years at present place, desires change. Address *Business Manager*, care of Marine Engineering.

Foreman Joiner desiring change will consider opening; 22 years' experience, all classes of work. At present employed, at liberty after due notice. Address *Joiner*, care of Marine Engineering.

Wanted—Position as Purchasing Agent. Ten years' manufacturing and shipyard experience. Desires to make a change. At present employed by large shipyard on Atlantic Coast. Address *Box* 22, care of Marine Engineering.

Heavy Oil Engine Designer and Works Manager open for an engagement. Diesel engine marine work preferred; wide experience abroad and in this country. Address *Box* 14, care of Marine Engineering.

Attention! Naval Architects, Consulting Engineers and Shipbuilders. Do you need drafting help? To secure charge man and grade "A" draftsmen for a few hours per day, address *Charge Man*, care of Marine Engineering.

Wanted—Twelve Steel Hull Draftsmen. Tanker and General Merchant Vessels. North Atlantic Coast. Give detailed experience and salary in first letter. References required. Permanent position. Address *Box* 83, care of Marine Engineering.

For Sale Cheap—A Pair of Triple Expansion Seabury Engines, 8, 12½ and 20 x 10 stroke, Condenser and Seabury boiler, plant complete, all in perfect condition. *New York Yacht, Launch & Engine Co.*, Morris Heights, New York City.

Marine Draftsman—Large shipyard in vicinity of New York has openings for the following men: Turbine Designer, preferably man with experience in designing Parsons turbines; Marine Steam Engine Designer; Engine, Pipe and Electrical Draftsman; technical graduates preferred. Positions permanent, with excellent opportunities for advancement. Address *Box* 798, care of Marine Engineering.

Draftsmen—Both Hull and Marine Engine Draftsmen wanted for a new ship yard in Maryland. Rare opportunity to get in on ground floor and develop with new organization. State qualifications and salary. Address *Box CB*-5, care of Marine Engineering.

Wanted—Several Loftsmen for New England shipyard. Men familiar with both transverse and longitudinally framed merchant vessels desired. Outline experience in detail. Give references. Permanent positions with good opportunities. Address *Box* 416, care of Marine Engineering.

Chief Hull Draftsman with twenty years' experience is open for position with shipbuilding or steamship company. Thorough knowledge of estimating, designing and construction of merchant and naval vessels. Practical knowledge of marine engineering. Address *Box* 17-*A*, care of Marine Engineering.

First Class Ship Draftsman, University Graduate Naval Architecture, 12 years' shipyard experience, will make designs, calculations, specifications, classification plans, lines, details for steel and wooden freighters, oil tankers. Charges moderate. Address *Changeman*, care of Marine Engineering.

Hull Draftsman, having ten years' experience on new working plans for battleships, torpedo boats, oil tankers, passenger and freight steamers, desires position with some reliable shipbuilding firm. References furnished. Address *Box* 123, care of Marine Engineering.

Wanted—Several Loftsmen for New England Ship Yard. Men familiar with both transverse and longitudinally framed merchant vessels desired. Outline experience in detail. Give references. Permanent positions with good opportunities. Address *Box* 84, care of Marine Engineering.

Position Wanted as Steam Specialty Man or Pipe Foreman; 42 years of age; 12 years' experience as general foreman pipe department marine shop on repair and new work. Has served in a position as engineer. Best references. Address *Box* 11, care of Marine Engineering.

Port Engineering—Man with 32 years' experience in marine work, Chief Engineer since 1898; Marine Superintending Engineer in France with A. E. F. for one year. Technical and practical training; conversant with turbines and reduction gears. One year in charge of trial trips for E. F. C. Desires to connect with an operating company as Port Engineer. All details at interview. Address *Box* 43, care of Marine Engineering.

Mechanical Engineer with college education having full charge of machinery in large shipyard on Atlantic Coast, desirous of making a change. Wants position with engineering or contracting company. Has the handling of men. Age 44 years. Salary $85 per week. Address *Box W*-4, care of Marine Engineering.

Designing Draftsman, with electrical, steam engine, turbine or special machine experience, wanted for permanent position with large manufacturing concern in New England. Applicant give age, experience, education and salary expected. Address *Chief Draftsman, Box* 50, care of Marine Engineering.

Naval Lietuenant, with nine years' practical operating experience in engineering department of vessels with various types of installations, desires position as Chief Engineer of ocean steamer or yacht. Licensed as unlimited chief; 32 years of age; unmarried. Will consider $4,000 salary. Expect to be released June 1. Correspondence invited. Address *Chief Engineer*, care of Marine Engineering.

A Progressive and Practical Shipbuilder, 20 years' experience, superintendent of hull construction with a good organization of foremen and first-class hull mechanics; now employed in a large Emergency Fleet Corporation yard that will soon close, would like to locate with a permanent yard whose efficiency of production is below the best yards. Would consider any of the following positions: Works Manager, Assistant Works Manager, Superintendent or Assistant Superintendent of Hull Construction. Understands berthing system that has increased the efficiency of all hull crafts, riveting gangs now averaging above 60 rivets per hour. Understands structural steel shop methods. Address *Box* 595, care of Marine Engineering.

Government Sales

Sealed pids will be received until 11 o'clock A. M., April 7, 1920, by the United States Shipping Board Emergency Fleet Corporation, at the office of the Manager of the Supply and Sales Division, Sixth and B streets, S. W., Washington, D. C., for the sale of the said Corporation's Shipbuilding Plant at Wilmington, N. C., including the tools and equipment.

The property offered comprises about 42 acres used for shipyard purposes with 1,600 feet of waterfront, is located on the Cape Fear River, within the limits of the city of Wilmington, N. C., with spur to Atlantic Coast Line R. R. This yard has been one of the efficient shipyards in the South Atlantic District for the building of concrete ships of 3,500 D. W. T.

Detailel inventory, blueprints and photographs and other data of said shipyard have been filed in the office of the manager of the Supply and Sales Division, Sixth and B streets, S. W., Washington, D. C., and may be inspected by prospective bidders during business hours. Copies of a description of the yard, abstract of inventory and any further information, may be obtained on application.

Bids must be submitted in duplicate on standard proposal forms and enclosed in a sealed envelope marked "Proposal 3021.

General News and Technical Notes

TWENTY-ONE SHIPPING CONCERNS ORGANIZED IN MARCH

Capital of $61,850,000 Involved—Twelve Companies of $1,000,000 or more—Previous Records for March Broken

New enterprises in the shipping, shipbuilding and allied industries involved the organization during March of twenty-one companies, with an authorized capital of $50,000 or greater, the total indicated investment in these concerns appearing as $61,850,000. Both in point of the number of companies formed and of aggregate authorized capital the March record represents an improvement over the preceding month, when seventeen concerns were launched with an aggregate authorized capital of $33,380,000. The March figures compares with $9,276,000 in March, 1919, and is larger than for any month of last year. It is roughly $14,500,000 below the January total, however.

The indicated investment in new shipping enterprise during the first quarter of the current year, as shown by the compilation of *The Journal of Commerce*, is $171,535,000. This compared with $23,201,000 for January-March, 1919, the gain of approximately 641 percent reflecting the growth of interest in the American merchant marine. It should be noted in connection with this comparison, however, that the first quarter of 1919 was a period when the general reaction in virtually all lines of industry and enterprise was most severe following the armistice.

Twelve companies were organized in March, with an authorized capital of $1,000,000 or greater. These were the American Coastwise Steamship Company, $5,000,000; American Merchant Mariners, Inc., $5,000,000; Disappearing Propeller Boat Company, $1,200,000; European Navigation Company, $1,500,000; Farragut Steamship Corporation, $1,000,000; International Coal Transportation Corporation, $2,700,000; Lord Drydock Corporation, $20,000,000; Pequot Steamship Company, $1,500,000; Perhaspake Towing & Transportation Corporation, $2,000,000; Russian, Slavic & American Steamship Corporation, $3,500,000; Submarine Exploration & Recovery Company, $10,000,000, and the Seattle Shipbuilding & Dry Dock Corporation, $5,000,000. Only seven companies of such proportions were started in February, ten in January.

The following list comprises names, State of incorporation and authorized capital of new shipping companies organized in March, 1920:

American European Line, Inc., Del.	$100,000
Am. Coastwise Steamship Co., Del.	5,000,000
Am. Stand. Shipfittings Corp., Del.	800,000
Am. Merchant Mariners, Inc., Del.	5,000,000
Brown Navigation Co., The, Del..	150,000
Cananova Steamship Corp., Del....	525,000
Cayo Mambi Steamship Corp., Del.	525,000
Disappear'g Propeller Boat Co., Del.	1,200,000
European Navigation Co., Del....	1,500,000
Farragut Steamship Corp., Del....	1,000,000
Independ't St'mship Co., The, Del.	500,000
International Coal Transportation Corp., Del.	2,700,000
Lord Drydock Corp., Del..........	20,000,000
New York & Baltimore Inland Transportation Co., Del........	300,000
Northsea Co., Ltd., Del............	350,000
Pequot Steamship Co., Del........	1,500,000
Perhaspake Towing & Transportation Corp., Del.	2,000,000
Russian. Slavic & American Steamship Corp., Del.	3,500,000
Submarine Exploration & Recovery Co., The, Me..................	10,000,000
Seattle Shipbuilding & Dry Dock Corp , Del.	5,000,000
Swiftsure Oil Transport, Inc., N.Y.	200,000
Total	$61,850,000

TO CLASSIFY U. S. SHIPS

American Bureau Will Survey For Shipping Board

An arrangement has been made between the Shipping Board and the American Bureau of Shipping, 66 Beaver street, whereby all Shipping Board vessels, some 500 in number, now having Lloyds classification only, will be classified by the American bureau.

This matter was brought up while Judge Payne was chairman and he favored it, provided the American Bureau took over the classification without cost to the government. The American Bureau originally asked $150 a ship.

Commodore E. P. Bertholf and Captain C. A. McAllister, vice-presidents of the American Bureau, agreed to the proposal of Judge Payne, with the understanding that they will make all future surveys on the vessels taken over.

This means the formal recognition of the American Bureau of Shipping as the official classification service for American ships so far as the Shipping Board vessels are concerned.

International Trade Conference

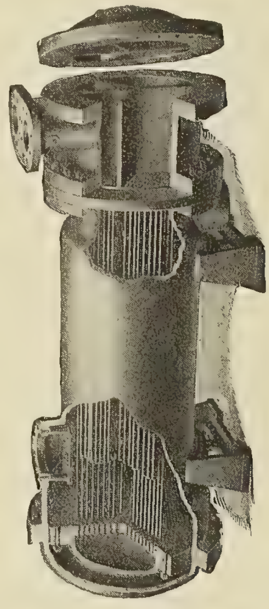
The United States Chamber of Commerce has invited Great Britain, France, Italy and Belgium to a joint commercial mission, to be held at Atlantic City during the week of September 29.

The Herreshoff Manufacturing Company, Bristol, Conn., has received a contract from Carl E. Tucker, New York, to build an 80-foot waterline schooner yacht for the 1920 yachting season.

Instantaneous Water Heater

A new heater has been designed by the Griscom-Russell Company, New York City, to be used as a boiler feedwater heater, or wherever quantities of water are to be heated by live steam.

The system provides for the water to pass through tubes fastened in a shell, through which live or exhaust steam circulates. The water passing rapidly through either two, four, six or eight sections or tube bundles is rapidly raised to the desired temperature. It is claimed that the heater can be operated far in excess of its rated capacity with only a slight reduction in the final temperature of the water. The shell and head covers are of cast iron, while the tube plates are of rolled steel. The heating surface con-



Instantaneous Water Heater

sists of ⅝-inch outside diameter seamless brass tubing. Tubes are expanded into the tube sheet; one tube plate is attached rigidly to the shell, while the other of the floating type permits the tubes to expand and contract without any strain on the joints.

The shell is designed for a steam working pressure of 50 pounds per square inch, and the tubes and water chambers for a pressure of 250 pounds per square inch. Saddles are supplied for supporting the heaters in horizontal or vertical positions as desired.

Cammell, Laird & Co., Ltd., Birkenhead, Eng., have booked an order for two geared turbine steamers for the Osaka Shosen Kaisha, of Nagasaki. The vessels are to displace 15,000 tons, and will have a sea speed of thirteen knots.

Each Block Stamped With Its Safe Working Load

PARISH

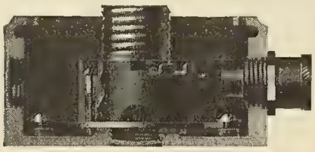
SUPPLY & MFG. CO.

2856 QUINN STREET, CHICAGO

Marine Electrical Fixtures

Several new devices for marine electrcial installations have been produced by the Seidler-Miner Company, Detroit, Mich. These include the Universal Conduit Box having a false bottom plate to which all wiring is fastened, and which provides a better means than fixed bosses for the holding-down screws of wiring devices. Because of the fact that this plate is supported at its outer edge by bosses having washer head screws, holes may be made in the plate for different spacings, and the projecting screw ends thus be allowed clearance in the intervening space. Because of this clearance, devices such as key sockets may be swung around to bring the key to any desired point, regardless of what angle the screw holes are placed in relation to the key.

The S-M U-Box, as it is designated, is also provided with the usual bottom bosses and standard screw spacing for Bryant devices, hence may be used without the bottom plate if desired.

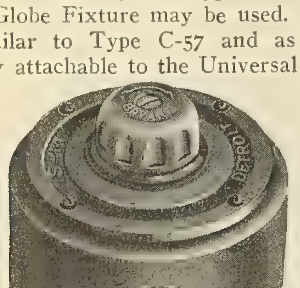


Cross Section S-M U-Box

Another feature of the box is the threaded outlet which is ready for a pipe connection at all times by simply knocking out a plug. It may, therefore, be used either as an outlet box or as a fixture body.

Another of the devices, the S-M Type C-57 globe holder for 3½-inch diameter globes and 60 watt lamps, may be quickly and solidly clamped to the S-M Universal Box. When larger lamps up to 150 watts are desired, the Type E Watertight Globe Fixture may be used. This is similar to Type C-57 and as such readily attachable to the Universal Conduit Box. It is made of brass and furnished with a 4¼ by 8-inch, Type E globe and a Type E guard. By the addition of this unit the S-M convertible devices may be used for from standard 60-watt equipment up to 150-watt.

Cross Section S-M Type C-57



S-M Water Tight Switch

The C-57, Type E, and other types of globe holders may be fitted with Bryant watertight receptacles for several uses in places exposed to the weather.

Another special device is the S-M watertight switch, which includes the Universal Box fitted with a cover having the Bryant watertight switch mechanism. The combination includes either a 5-ampere, single or double pole switch. The Universal Box may also be fitted with a Bryant watertight plug and plug receptacle in either the single or multiple box type. The multiple box Type DB-DC includes both the Bryant plug and Bryant switch as described above.

A complete catalogue of marine electrical fixtures will be supplied by the Seidler-Miner Company on request.

BUILDING ON OWN ACCOUNT

Coughlan Concern, Vancouver, B. C., First in Canadian Field

The steamship Braeholm, now completing at the shipyards of J. Coughlan & Sons, Ltd., Vancouver, B. C., is said to be the first ship laid down by a Canadian shipyard to its own order. The company started construction in December last, and shortly afterward sold the ship for approximately $1,500,000. She is 8,800 deadweight tons, fitted with triple-expansion engines, and built to attain a loaded speed of 11.5 knots.

The Coughlan company is starting construction of the graving dock on Burrard Inlet. It will be completed in about thirty months at a cost of approximately $3,000,000. It will be 750 feet long, 110 feet wide. Repair shops will be part of the equipment, and there will be an auxiliary marine railway, capable of handling vessels to 8,800 deadweight tons. This will be operating in eighteen months.

Shipping Board Changes

Col. E. H. Abadie has resigned, effective May 1, as general comptroller of the Shipping Board, and Alonzo Tweedale, treasurer of the Board, has been appointed to succeed him. Mr. Tweedale will continue as treasurer of the Board until a successor has been appointed.

E. E. Palen, director of the South Atlantic District at Norfolk, has resigned, and has been succeeded by Captain W. E. Griffith.

Commissioner Thomas A. Scott has brought his work at Washington to an end, and officially ended his connection with the Shipping Board on April 15. His duties have been distributed between Commissioners John A. Donald and Raymond B. Stevens.

K. E. Hurlburt, secretary to Commissioner Scott, also severed his connection with the board on April 15.

Martin J. Gillen, Republican, of Wisconsin, has been nominated by President Wilson to succeed to the vacancy as Shipping Board Commissioner left by Henry M. Robinson of California.

SAVING TIME AND MONEY

The Vortex Painter Claims to Have Solved the Problem

A few of the characteristic difficulties of paint spraying are loss of paint, scattering and wind splashing over surfaces not to be painted, uselessness in the open air, owing to the interference and pre-drying of the paint to a chalky consistency through evaporation of its volatile oils while in the air.

The problem, as seen by the laboratory of the Vortex Manufacturing Company, Cleveland, Ohio, was to confine the paint jet to a definite radius while in transit from the nozzle to the surface to be painted; to reduce splashing and prevent volatilization. The solution took the form of what might be termed a hollow, conical air jet within which the paint is liberated.

The nozzle of the Vortex Painter has two openings—a central opening for paint and an annular opening around the center from which the air is discharged as a veritable blast under a pressure approximating 60 pounds to the square inch. There are separate conduits for air and paint, terminating in a right angle on each side, which forms an axis for the nozzle and permits it to be operated at any desired angle. Among the claims for the Vortex painter are carrying a greater volume of paint per minute, due to the fact that it is applied in a relatively heavy liquid jet, better penetration of rough surfaces, an efficient brushing action by the air jet which makes it possible to cover completely and smoothly with a single coat, and dispensing with scaffolding very largely by use of a 12-foot arm, when desired.

The Vortex Painter has consistently maintained records of 2,000 square feet per hour or more on plain interior work, where conditions were wholly favorable and the operator experienced in his task. In a recent job at the East Fifty-fifth street (New York) gymnasium, figures of the time spent in previous hand painting made a good basis for comparison. Panels 104 square feet in size had been hand-painted by two men at an average of 35 minutes per panel for a single coat. The Vortex appliance handled by one man did a panel every 5 minutes, and the single application equaled two or perhaps three brush-applied coats in cover. Possibly a more striking demonstration was the painting of a huge storage tank on the roof of the new Overland building in Cleveland. This was given a single, but sufficient, protective coating of red in 3½ hours, covering 3,500 square feet of surface.

No ladders or scaffolding were required. To make the test more difficult, there was a high wind at the time. One painter, with the aid of a helper in handling and arranging the hose, did the whole job.

BIG TANKER CONTRACT

Norway-Pacific Company To Build for Norwegian Concern

M. G. Thomle, president of the Norway-Pacific Shipbuilding Company, which has installed a large shipyard in Everett, Wash., has sent the following telegram from New York to Seattle shippers: "Have closed contract for our company with Norwegian Tankers Company, Ltd., of Christiania, for five 10,600-ton tank steamers, totaling $11,000,000. These tankers are the first unit on tanker contracts to be let here for use in transporting oil from Mexico to Europe and the Orient. Oil storage stations are to be installed in all principal ports. One hundred million dollars have been subscribed by English and Mexican oil interests for construction of tankers and storage stations throughout the world. Our new contract carries preference on this business up to our capacity."

Engineering Firms Merge

Of general interest is the combination recently announced of the organization of Westinghouse, Church, Kerr & Company, Inc., engineers and constructors, New York, and Dwight P. Robinson & Company, Inc., constructing and consulting engineers, of New York.

The new company will be called Dwight P. Robinson and Company, Inc., and will occupy executive offices at 61 Broadway, and engineering and designing offices in the Grand Central Palace, 125 East 46th street, New York.

Mr. Dwight P. Robinson, president of the new company, was for many years president of the Stone & Webster Engineering Corporation, and formed his own company in 1918. He has had an unusually valuable experience in the design and construction of industrial plants, central power stations and hydro-electric plants, and his company, the principals of which left Stone & Webster with him, has specialized in work of this nature. At the time of the merger the Robinson Company had large power plants under construction for the Duquesne Light Company, at Pittsburgh, the Penn Public Service Company, at Johnstown, Pa., and others.

Westinghouse, Church, Kerr & Company, Inc.—established thirty-six years ago—has specialized in the design and construction of industrial plants of all kinds, railroad shops and terminals, and industrial power plants.

As the activities of the two companies were largely supplemental—each making its own specialized contribution to the new company—it is believed that the new organization will become one of the largest and most successful in the construction and engineering business.

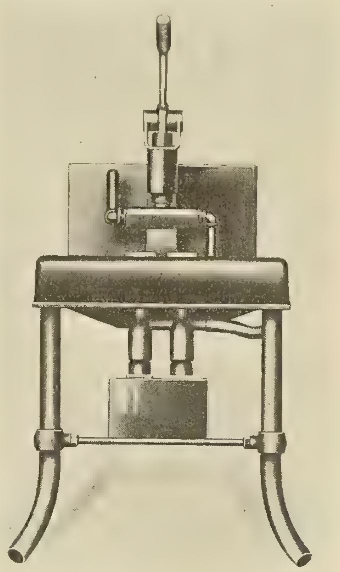
Atkins Slotting Machine

Alfred Herbert, Ltd., 54 Dey street, New York City, have announced the production of the Atkins 6½-inch Slotter. The machine is cone-driven and is equipped with automatic feeds to both slides and circular table. This table is of large diameter, graduated in degrees, and has a locking device with twelve divisions. The general specifications of the machine are described in a bulletin issued by the company and may be obtained upon request.

Electric River-Heating Forge Developed

A new electric rivet-heating forge is being produced by the United States Electric Company, New London, Conn. It is intended for use in shipyards, boiler shops and in connection with steel structural work—in fact, wherever it is necessary to use hot rivets from ¾ inch to 1¼ inches in diameter. It is stated that for these sizes from 7 to 15 seconds is required to attain the proper heat.

The electrodes of this heater are arranged to heat two rivets at a time, and about four rivets are supplied a minute at the proper heat and free from scale. The pan of the forge is designed to hold a keg of rivets. These are fed to the machine by hand. The conductor is operated by means of a foot or hand lever which brings the electrode in contact with the point of the rivet. When the rivet is adequately heated the pressure on the lever is released.



Electric Rivet Heating Forge

The forge may be supplied with a set of electrodes and twenty foot leads to be used in heating loose rivets in place, after which they may be driven up tight.

Equipments are available in all sizes and for use with 110 and 220 volts alternating current.

The St. Louis sales office of the Standard Underground Cable Company, Mr. E. J. Pietzcker, manager, was removed a short time ago from the Security Building, where it has been located since 1897, to the Arcade Building.

More Zinc Used in Government Paints

Standard paint specifications under which the Government is recommended hereafter to purchase paints for use of the Army, Navy and other departments, have been determined upon by the Inter-Departmental Committee for the Standardization of Paint Specifications.

Two features are significant: First, the importance of zinc oxide in increasing proportions is recognized by paint technologists on the committee; second, the latitude afforded by the specifications permits a large field of paint manufacturers to compete for Government business. The pigment proportions of the specifications follow:

	Minimum Percentage	Maximum Percentage
Zinc oxide	30	55
Lead (total, including either one or mixture of carbonate and sulphate)	45	70
Inerts and colors.....	0	15

The purpose of these specifications is to provide for the purchase of prepared paints generally available in any section of the country, without requiring paint manufacturers to make up special batches. It is believed these specifications will include the formulæ of the majority of high grade paints on the market.

Evans's Flagship as Target

The old battleship *Iowa,* once the pride of the American fleet and flagship of the late "Fighting Bob" Evans, will be used as a moving target for modern dreadnaughts while being operated by powerful wireless apparatus. For six months she has been lying out of commission at the Philadelphia Navy Yard. The *Iowa* is about thirty years old, and of little further use as a fighting machine. If plans work out, she will move as if under her own steam with a full crew. The contrivance to be employed is that of John Hayes Hammond, Jr., for the wireless control of torpedoes from land.

New National House Organ

The Greenfield Tap and Die Corporation, of Greenfield, Mass., is issuing a new national or exterior house organ entitled "The GTD Helix." This firm has been publishing an employee's edition for two years, but has felt the need of a publication more national in scope—hence the new "GTD Helix." The name "Helix," which means "the path of a true screw thread," is a particularly fortunate choice in view of the firm's product—which consists of tools for cutting and gaging screw threads. The new magazine is 4½ by 5⅞ inches, and the cover is strikingly laid out in colors—the principal design representing a screw thread as seen inside a nut or tapped hole—the path of the thread or "helix" bringing the reader's eye down to the feature item for the month. The first number was published in April.

SUN Marine Oils

Viking Marine Engine Oil for Thrust Bearing and Reciprocating Engine Lubrication.

Viking Engine Oil is a newly developed marine oil. It conforms in efficiency with the accepted high standards which for years have been maintained in Sun XX Marine Oil.

A special refining process enables it to form a perfect and lasting emulsion with either salt or fresh water. Viking Oil is neutral in reaction and contains no fatty acids, thus eliminating the corrosion of metal parts produced by the high acid content of the majority of marine engine oils. It will not deteriorate and become rancid with age, and is unaffected at low temperatures.

Sun Turbine Oil for Marine Turbine Lubrication.

Sun Turbine Oil is a high grade oil which possesses low internal frictional values and separates readily from water. It maintains its viscocity under high temperatures, insuring efficient lubrication under all conditions.

Monitor Cylinder Oil.

Monitor Cylinder Oil has high flash, high fire and high viscocity—necessary characteristics of the correct oil for marine cylinder lubrication. It contains no animal fats.

The engineers of Sun Company are always available for consultation regarding the most efficient type of oil to meet any condition.

SUN COMPANY

Producer, Refiner and Distributor
of Petroleum Products
PHILADELPHIA

Refineries: Marcus Hook, Pa.; Toledo, Ohio; Yale, Okla.

STOCKS CARRIED AT

New York City, Boston, Philadelphia, Baltimore, Pittsburgh, Cincinnati, Buffalo, St. Louis, Chicago, Minneapolis, Toledo, Newark, Newport News, Detroit, Atlanta, New Orleans, Sabine

MAY USE DIESEL ENGINES

Submarine Boat Corporation To Build 9,000-Ton Freighters

The twenty new freighters which the Submarine Boat Corporation, 5 Nassau street, New York, has announced it will build for sale to private interests, will be the largest fabricated ships afloat, as they will have a deadweight register of at least 9,000 tons. While the builders are figuring on both steam and Diesel engines for the projected freighters, it is understood that there is a strong likelihood that some of them will be equipped with the internal combustion engines.

Theodore E. Ferris, 30 Church street, the well known naval architect, is the designer of the new boats. Before the signing of the armistice, he had completed the specifications for the larger sized ships. The designs were changed after the war, as it was believed that the most economical cargo ship would be around 9,000 deadweight tons, with a speed of twelve knots, and a draft of about twenty-five or twenty-six feet.

Against Ontario Ship Canal

WASHINGTON, April 14.—Construction by the Government at this time of a ship canal to connect Lakes Erie and Ontario is disapproved in a report sent to Congress to-day by the Engineer Corps. The report said the canal would not justify the expense until an outlet for deep-sea ships through the St. Lawrence had been provided.

Westinghouse Has Marine Department

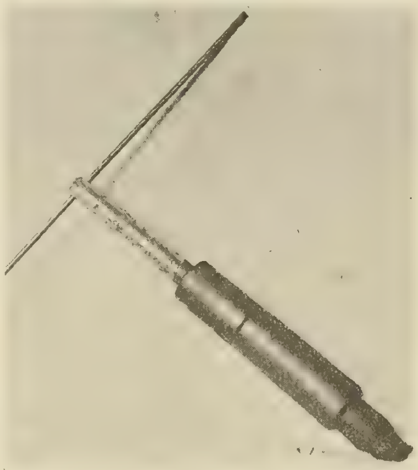
The Westinghouse Electric & Manufacturing Company has established a division of its Marine department at 165 Broadway, New York, to give the shipping industry the fullest service wherever knowledge, training and skill can be useful in the selection of ship propulsion machinery. The work of this division will be handled by Frank F. Boyd and Norris R. Sibley. Lt. Commander Boyd, U. S. N. R., was "Senior Engineer Officer" (chief engineer) of the *Jupiter*, the first electrically propelled ship of the Navy. Later he was transferred to the United States submarine base at New London, Conn., as chief engineer. He was in reality industrial manager. He is a member of the American Society of Mechanical Engineers, and kindred organizations.

During the war with Germany, prior to January, 1918, Mr. Sibley served as chief engineer in the Army Transport Service. Prior to that he had served in several of the lines of the Merchant Marine and for a time covered the marine field for New York newspapers and assisted in compiling "The Blue Book of Facts," a book on marine engineering. Leaving the Army Transport Service, he became connected with the Westinghouse Electric & Manufacturing Company. He is an alumnus of the Massachusetts Nautical School, a member of the National Marine League, and various marine engineering associations.

Convenient Electrode Holder

A patent has recently been allowed to L. A. Eckenrode, Park avenue, Chambersburg, Pa., on an electrode holder that eliminates the usual spring clip of such devices.

It is claimed that the holder cannot be injured by accidental contact. In practice one member of the holder rotates on the other, actuating a plunger against the electrode. A quarter turn of the handle



Electrode Holder Eliminates Spring Clip

is sufficient to clamp the rod in place, so that springs are not needed. The cable connection is also of special design

Further information of this device is available at the above address.

New Name in Oxy-Acetylene Field

The Oxweld Acetylene Company, of Newark, N. J., and Chicago, has recently extended its manufacture of oxy-acetylene apparatus and equipment to include "Eveready" welding and cutting outfits. "Eveready" is a new name in the field, but excepting for certain refinements of design, the apparatus has been used extensively in the metal-working trades for several years under the name of "Prest-O-Lite."

The new name was adopted to suggest the ready convenience, adaptability and general-purpose uses of the equipment. The apparatus is designed to be used exclusively with compressed acetylene in cylinders, thus providing for the welder and cutter a compact and complete portable outfit.

"Eveready" outfits and supplies are moderately priced, and are sold through distributors direct to the retail trade.

Flour Shipments Waiting

Four hundred thousand tons of flour intended by the Food Administration for shipment to the Atlantic Coast remain in Pacific Coast ports for shipment for June 1, when the Food Corporation ceases to function. Of this amount 200,000 tons remain to be shipped out of the Columbia River.

TO ENTER FOREIGN TRADE

Old Dominion Line Will Have Mediterranean Service

The Old Dominion Steamship Line, which recently announced that it was going out of the coastwise trade between this port and Chesapeake Bay points, is preparing to enter the Mediterranean and Black Sea service with a fleet that finally will comprise twenty steamships, including six passenger carriers, one being unusually large and all modern.

H. B. Walker, president of the Old Dominion Line, which will not change its name, made the announcement.

The Old Dominion service has been in existence fifty-three years. The line will retain its piers at the foot of Beach street, North River, extending them to suit the larger ships it will acquire.

Columbian's Cafeteria

The Columbian Rope Company, of Auburn, N. Y., has opened one of the finest and best equipped employees' lunch room in this section of the country. The building is 70 by 100 feet, one-story high, with an ample supply of fresh air and ventilation, and a seating capacity of 450.

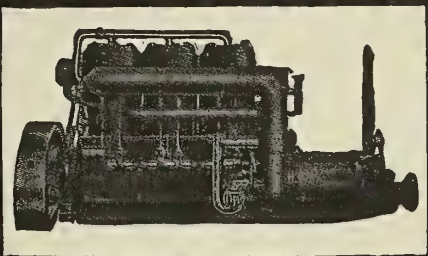
The company puts up a 25 cent lunch which includes choice of meat order, bread, butter, coffee, choice of a vegetable and of dessert; home-made muffins, rolls, etc., will be served. In addition, there will be a regular cafeteria service at actual cost. Those who carry their own lunch may eat at the tables and purchase coffee, tea, milk, etc., to fill out their lunch. Extra large "man-size" coffee mugs have been provided.

For the convenience of employees, a full supply of cigars, tobacco, chocolate, etc., is provided. Smoking will be permitted from 12:30 to 12:55 o'clock, which is much desired by the employees, as they are not allowed to smoke or carry matches within the grounds.

"Eldo" Incorporates

Ellenwood & Doyle, of 29 Great Jones street, New York City, who have just completed their first year as distributors of tin plate, black and galvanized sheets, copper, brass, zinc, etc., in order to provide additional capital for their rapidly expanding business, have decided to incorporate under the laws of New York State for $150,000 8 per cent preferred stock and 1,000 shares of common stock of no par value. The success which has resulted from their initial efforts, and which necessitated the leasing of one of the Bush Terminal buildings for warehouse accommodation, is no surprise to their many friends. The system of profit sharing inaugurated by this company cannot but attract and develop the best men available in this field, and the same generous spirit which pervades their dealings with their employees will not be withheld from the shareholders.

POWER



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"The Motor With the Bore & Stroke"

PLUS FUEL COST REDUCED

From 70 to 80 per cent without sacrificing reliability, flexibility or control. Perfect combustion on kerosene or lowest grade of Coast Distillate.

5 to 200 H. P. — 1 to 6 Cylinders

Ask for Catalog 73.

WOLVERINE MOTOR WORKS, Bridgeport, Conn.

STRATFORD SPECIAL NO. 1 MARINE OAKUM

receives the highest classification of the American Bureau of Shipping and Lloyd's Register of Shipping. It meets the requirements of all of the United States Government specifications. For years we have guaranteed the quality of each bale to be standard of excellence and returnable at our expense if otherwise. More of this grade Oakum has been used by the United States Government and its contractors than all other makes combined, yet, not a single bale has been condemned or rejected, whereas it has replaced the condemned Oakum of almost every other make. Our experience, quality and service are worth more to you than we ask.

GEORGE STRATFORD OAKUM COMPANY **Jersey City, N. J.**

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INTERNATIONAL
COMPOSITIONS FOR IRON AND STEEL VESSELS' BOTTOMS

In use and in stock at all ports of the world. **Over 18,000,000 gross tons of shipping coated annually**

Proprietors of INTERNATIONAL COMPOSITION, ANTICORROSIVE, and ANTIFOULING

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FOR SALE

Triple Expansion Marine Engine 18" x 32" x 54"—42" stroke. Has been in service fifteen lake seasons in a wooden steamer of 3000 tons capacity. Has been thoroughly overhauled and is in A-1 condition. Shipping weight approximately 70 tons.

Windlass, 8 x 10 of Providence manufacture, suitable for 1¾" stud link chain. Arranged for capstan drive. In first class condition.

Both subject to inspection. Immediate delivery.

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In all the various grades it is the best for the money—the most serviceable. Pound for pound it will go further and do a better and a more lasting job than any other make. Do not be deceived by cheap imitations; see that the trade mark is on every package.

Send for booklets: "MARINE GLUE—WHAT TO USE AND HOW TO USE IT" and "HOW TO MAKE YOUR BOAT LEAK PROOF"

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UNION DRY DOCK & REPAIR CO.
Vessel Repairs in Wood and Iron

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Dry Docks and Shipyard Adjoining West Shore Ferry
TELEPHONE, 904-905 UNION

PERSONAL AND BUSINESS NOTES

Canadian offices of Alfred Herbert, Ltd., New York City, have recently been opened in Toronto in the Board of Trade Building, 31 Yonge street. J. C. Blair will be in charge.

The general and Philadelphia District sales offices of the Tacony Steel Company have removed from the works to the Franklin Bank Building, 1417 Sansom street, Philadelphia.

Mr. J. L. Edwards now represents the Mahr Manufacturing Company of Minneapolis, Minn., makers of oil-burning equipment, in Western Pennsylvania, with an office at 498 Union Arcade Building, Pittsburgh. Mr. Edwards succeeds Mr. J. S. Longnecker.

Large foreign orders, together with the demand from American railroads, shipyards and industrial plants, have been responsible for extensive improvements and additions in the Baird Pneumatic Tool Company's plant at Independence, Mo., near Kansas City, in which latter city are the general offices of the company. Another battery of automatic lathes and a giant planer have recently been installed to take care of the increased foreign demand for labor saving machines. China and Japan head the list of foreign buyers, with a constant stream of inquiries from Europe.

Mr. J. A. Ridley, a superintendent of fitting, launching and finishing mine planters at the Fabricated Ship Corporation, Milwaukee, Wis., since May, 1919, has been appointed manager of the yard at Kewaunee, which is being equipped by the Wisconsin Shipbuilding & Navigation Corporation, 216 West Water street, Milwaukee. Mr. Ridley had many years experience in practical shipbuilding in England, before coming to the American Lakes in 1910, and has a South Kensington certificate in naval architecture.

The Baird Pneumatic Tool Company of Kansas City, Mo., will exhibit its full line of compression pneumatic tools and its flue rattler at the Master Mechanics' Convention at Atlantic City, June 9 to 16.

The Metal & Thermit Corporation, 120 Broadway, New York City, in order to take care of its increasing business in the New England States and Canada, has appointed Mr. James G. McCarty manager of its Canadian branch, with headquarters in Toronto, and has transferred Mr. Robert L. Browne from its New York office to Boston, where he will have charge of all sales in the New England States.

The Baker R. & L. Company, Cleveland, Ohio, announce an expansion of their business which will allow for greater production of Baker industrial trucks and Raulang bodies. The change includes the sale of the electric passenger car business to Rauch & Lang, Inc., of Chicopee Falls, Mass. The Baker R. & L. Company built the first electric road vehicle offered for sale on the American market and fifteen years ago attracted much attention with the Baker Torpedo Kid, an electric racing car that established the world's kilometer record, and attained a speed of 128 miles per hour at Ormond Beach, Fla.

The Brown Instrument Company, of Philadelphia, is erecting two new buildings, one for the manufacture of recording thermometers, the second a research department, at a cost of $100,000. These facilities will enable the company to materially increase the output of Brown pyrometers and recording thermometers.

The Independent Pneumatic Tool Company, Chicago, Ill., announces with profound sorrow, the death of Mr. Roger C. Sullivan, Chairman of the Board of Directors, on April 14, 1920.

Mr. A. C. Wilkie, having resigned from the Emergency Fleet Corporation as manager of the Ship Construction Division, has opened a Philadelphia office at 1619 Chestnut Street, for Eads Johnson, M. E., Inc., of New York, Consulting Marine Engineers.

The Midwest Engine Company has recently completed the erection and equipment of a centrifugal pump and turbine testing laboratory at the Hill Pump Division, Anderson, Ind. This laboratory has facilities for testing centrifugal pumps up to 48 inches capacity, and the various types of reciprocating pumps handling up to 25,000 gallons per minute, produced in their works. Five units of the Midwest-Wait steam turbines may be handled simultaneously. A 2,000-square foot surface condenser is used for condensing units, and high pressure boilers and superheaters supply steam at any desired pressure or degree of superheat.

Charles Gitlan, 72 Trinity Place, New York City, an expert on non-ferrous metals and ores, is in the market as a buyer or seller for shipyards, boiler makers, engineers, tin plate makers, and other consumers, giving personal attention to all inquiries.

G. E. Stoltz, general engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed engineer in charge of the steel mill section, and W. E. Thau has been made engineer in charge of the marine section of the engineering department.

Ray T. Middleton has resigned as general sales manager of the Standard Steel Castings Company, of Cleveland, to become vice-president and director of sales and advertising for the Kelly Metals Company, of Chicago, Detroit and Los Angeles. Mr. Middleton's headquarters will be Chicago, where The Kelly Metals Company will, at an early date, establish its principal production plant. The company will continue its present plant in Duluth and Los Angeles, and later establish a third branch plant at a point to be selected in the East.

All standard sizes of rivet sets are being manufactured by The Ward Tool & Forging Company, Latrobe, Penn. The company is also prepared to supply special rivet sets according to any specification.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
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NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
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UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

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National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 808 Vine St., Camden, N. J.

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Vice-President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Secretary—B. G. Barnes, 6 Meadow Way, Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; E. H. Monroe, Washington, D. C.; John Thomson, Bethlehem, Pa.

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National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA
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INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
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INSTITUTE OF MARINE ENGINEERS, INCORPORATED
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Solid and Sectional

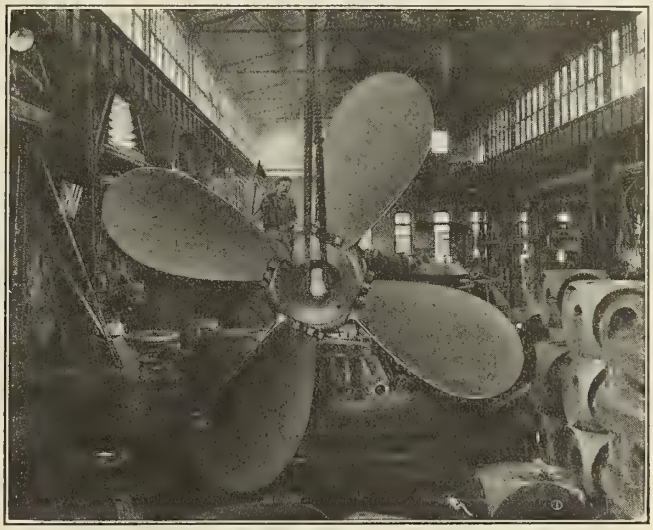
Manganese

BRONZE PROPELLERS

and

HIGH GRADE BRONZES FOR ALL ENGINEERING PURPOSES

WRITE FOR OUR SPECIAL CATALOG ON PROPELLERS



Showing one on an order of 40 propellers delivered by us for the HOG ISLAND CLASS "B" Ships.

Diameter 18′-6″—Weight 34,000 lbs. each.

American Manganese Bronze Company

Holmesburg Junction, Philadelphia, Pa.

Manufacturers of Spare's Bronzes

Bound Volumes of Marine Engineering

Every month's issue of MARINE ENGINEERING contains much valuable information and should be kept at hand for ready reference.

A bound volume gives you the key to what has been accomplished in the Marine Field during the year.

Many of these volumes (from 1897 to 1919) are out of print. We sell those in stock for $6.00 each.

MARINE ENGINEERING **6 East 39th Street, New York**

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Marine Plumbing Fixtures

Sands' meets all demands whether it be for a 30-foot launch or an ocean liner.

A. B. SANDS & SON CO.

22-24 Vesey Street New York City

AN OPPORTUNITY

for a young man with several years' experience in shipbuilding, preferably a college graduate, to enter a department handling technical publicity. Excellent prospects for advancement. In reply give age, education, experience and salary desired. Address Box 6, care of Marine Engineering.

HELP AND SITUATION AND FOR SALE

☞ ***No advertisement accepted unless cash accompanies the order.***

Advertisements will be inserted under this heading at the rate of 4 cents per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent per word. But no advertisement will be inserted for less than 75 cents. Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Boiler Designer—Large, permanent shipyard with every facility for the manufacture of marine boilers, wants first-class marine boiler designer. Plant located near New York. Send name and address for information. Address *Box* 24, care of MARINE ENGINEERING.

Designing Draftsman, with electrical, steam engine, turbine or special machine experience, wanted for permanent position with large manufacturing concern in New England. Applicant give age, experience, education and salary expected. Address *Chief Draftsman, Box* 50, care of MARINE ENGINEERING.

Oil Engine Drawings for sale in full sets of standard shop working drawings. For 5,000- and 9,000-ton steamers, four-cylinder, 24 by 36, 1,450 horsepower, by 96 sheets, $1,200; for tugs, four-cylinder, 18 by 27, $1,000, and four-cylinder, 16 by 24, $900. For yachts or as auxiliaries, steel column crosshead type, 10 by 12, $900; 6 by 8, $600; 4 by 5 trunk piston, $300. Address *Fuel Oil,* care of MARINE ENGINEERING.

Port Engineering—Man with 32 years' experience in marine work, Chief Engineer since 1898; Marine Superintending Engineer in France with A. E. F. for one year. Technical and practical training; conversant with turbines and reduction gears. One year in charge of trial trips for E. F. C. Desires to connect with an operating company as Port Engineer. All details at interview. Address *Box* 43, care of MARINE ENGINEERING.

A Progressive and Practical Shipbuilder, 20 years' experience, superintendent of hull construction with a good organization of foremen and first-class hull mechanics; now employed in a large Emergency Fleet Corporation yard that will soon close, would like to locate with a permanent yard whose efficiency of production is below the best yards. Would consider any of the following positions: Works Manager, Assistant Works Manager, Superintendent or Assistant Superintendent of Hull Construction. Understands berthing system that has increased the efficiency of all hull crafts, riveting gangs now averaging above 60 rivets per hour. Understands structural steel shop methods. Address *Box* 595, care of MARINE ENGINEERING.

Assistant Manager, Superintendent and Chief Engineer desires permanent position with up-to-date shipyard. Two years' experience in machine shop, 3½ years licensed as first assistant at sea, 12½ years in engine drafting rooms. Address *Box 99-K,* care of MARINE ENGINEERING.

Marine Engineer, with technical training, construction, drafting and sea experience, desires position as chief machinery draftsman, or in charge of machinery installation and outfitting work. Have had full charge of work for United States Shipping Board at large shipyard. Address *Box* 384, care of MARINE ENGINEERING.

Practical Shipbuilder wishes position as Hull Superintendent; thoroughly acquainted with berthing system; fifteen years' varied experience in shipyards on Atlantic Coast and Great Lakes; master mechanic on loft work; best of reference. Can report for work on short notice. Address *Hull Superintendent,* care of MARINE ENGINEERING.

Position as Assistant to experienced Shipyard Executive Wanted by Graduate Naval Architect. Has served at trades in wood and steel yards, hull and engine draftsman; holds papers, Superintendent in Production Department, Naval Architect; present position Superintendent. Unmarried, 28 years old. Will go abroad. Address *Box* 75, care of MARINE ENGINEERING.

Wanted—To Supervise and Inspect your Ship and Machinery Repairs, also Docking in New Orleans. At present employed, large plant, in charge machinery, boiler and hull repairs. Have spare time to supervise your work; am thoroughly familiar with docking and repair conditions in this port; 25 years' experience; can give reference. Address *"Supervision,"* care of MARINE ENGINEERING.

Naval Lietuenant, with nine years' practical operating experience in engineering department of vessels with various types of installations, desires position as Chief Engineer of ocean steamer or yacht. Licensed as unlimited chief; 32 years of age; unmarried. Will consider $4,000 salary. Expect to be released June 1. Correspondence invited. Address *Chief Engineer,* care of MARINE ENGINEERING.

Foreman on Steel Hull Construction, understands the supervision of all crafts, will be at liberty after May 15 to consider a proposition here or abroad. Age 26 years. Two years with present yard. Address *Box* 422, care of MARINE ENGINEERING.

Mechanical Engineer open for position. Twenty years' experience in designing, shop installation and trials on tankers and general freight steamers. Hold unlimited chief's papers. Address *Efficiency,* care of MARINE ENGINEERING.

Business Manager of Repair Yard, twelve years at present place, desires change. Address *Business Manager,* care of MARINE ENGINEERING.

Marine Chief Engineer of wide experience afloat and ashore would like position as Port Engineer for shipping company, or trial trip and superintending engineer in shipyard. Address *Box* 11, care of MARINE ENGINEERING.

Naval Architect and Marine Engineer open for an engagement. Wide experience abroad and in this country on all classes of marine construction. Address *Box* 81, care of MARINE ENGINEERING.

Wanted—Young Man as Salesman with Large Machinery Company. Single man with college and apprentice training preferred. Good opportunity for advancement for right man. Address *Box* 71, care of MARINE ENGINEERING.

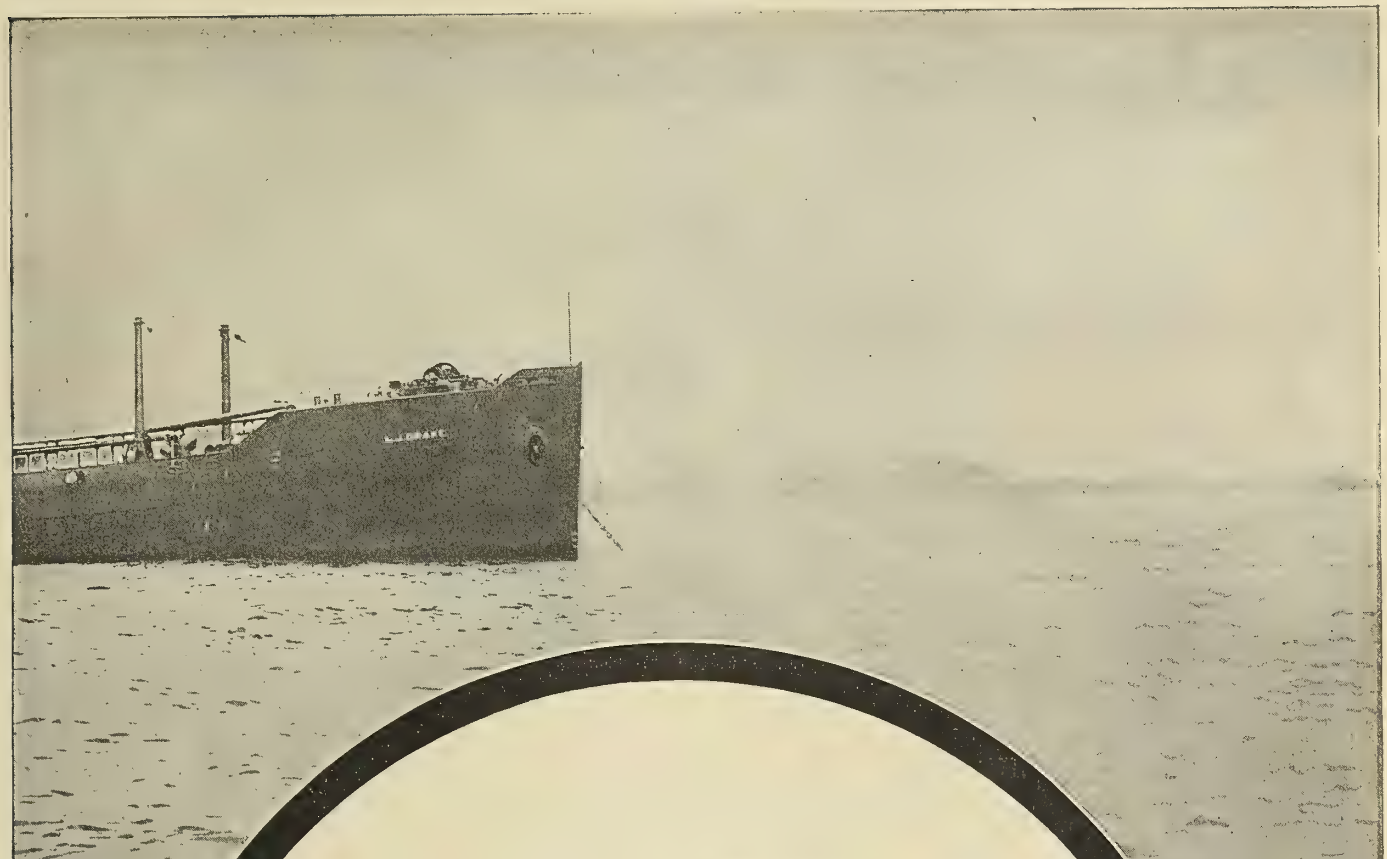
Naval Architect, now employed in that capacity in Atlantic Coast shipyard, desires to make change. Has twenty years' experience in design and construction of all classes of vessels. Address *Box A*-26, care of MARINE ENGINEERING.

Attention! Naval Architects, Consulting Engineers and Shipbuilders. Do you need drafting help? To secure charge man and grade "A" draftsmen for a few hours per day, address *Charge Man,* care of MARINE ENGINEERING.

Heavy Oil Engine Designer and Works Manager open for an engagement. Diesel engine marine work preferred; wide experience abroad and in this country. Address *Box* 14, care of MARINE ENGINEERING.

The Peerless Engineering Company, Cotehill, Halifax, England, announces that the present electrical equipment which has been developed for automobile installations has also been adapted to meet marine requirements. The principle features of motor, dynamo and starter construction are the elimination of aluminum parts, the substitution of cast-iron end plates and the use of heavy vulcanized cable recommended by the British Admiralty.


SS. L.J.Drake



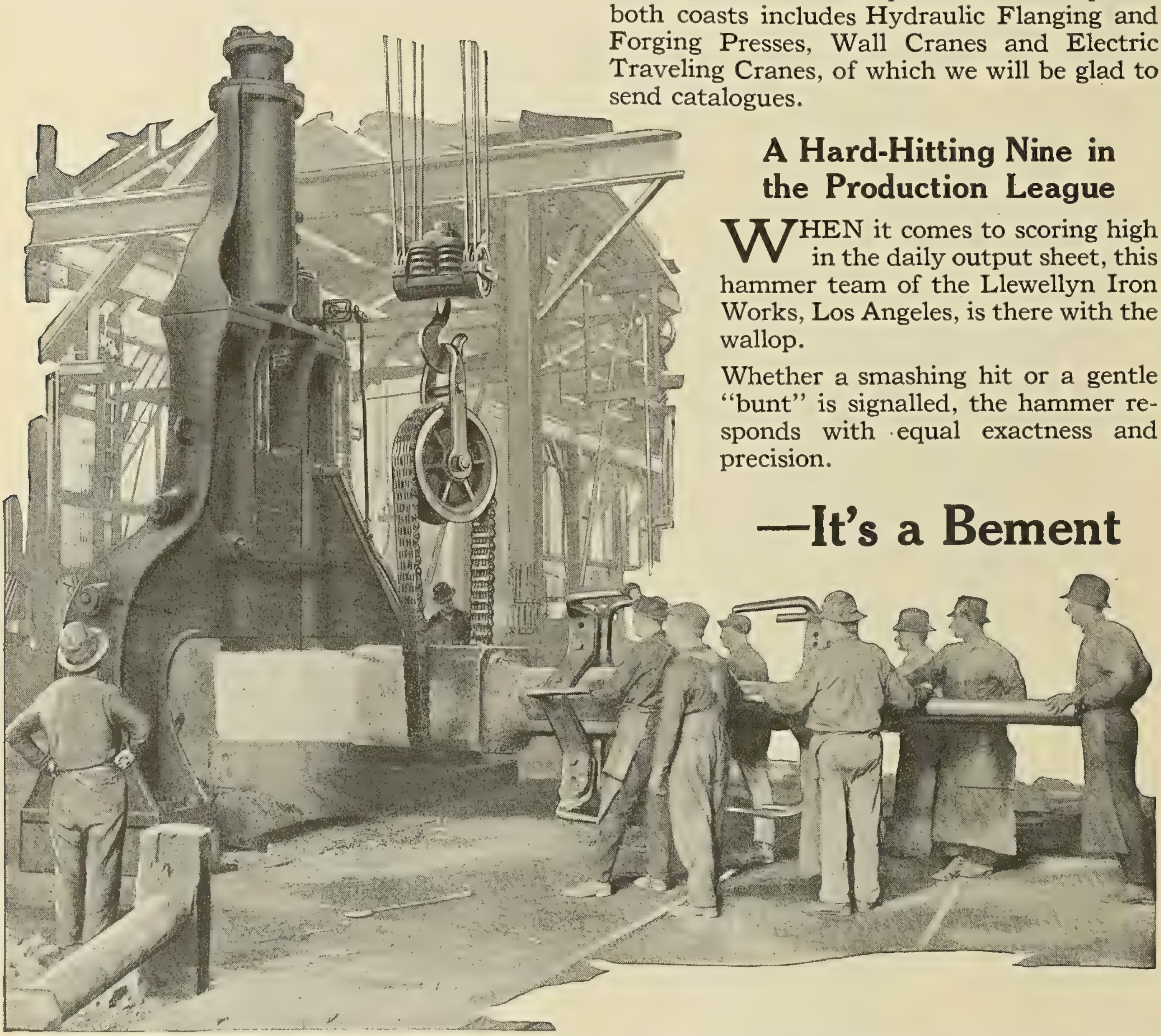
In the Forge Shop

N-B-P Steam Forge Hammers in single or double Frame, sizes up to 2,400 lbs., possess in ideal combination—enormous power, massive strength, simplicity and hair-trigger control. They are safeguarded against overtravel by internal buffer springs, which, together with the usual external springs, do away with all danger of knocking out cylinder heads through careless handling.

Bement Hammers include Steam Forge Hammers, single and double frame, up to 24,000 lbs. size; Steam Tilting Hammers from 500 to 3,000 lbs., and Board Drop Hammers from 300 to 1,500 lbs.

There's a Bement for every hammer requirement.

Other Niles Bement-Pond Forge Shop Equipment prominent in representative shops on both coasts includes Hydraulic Flanging and Forging Presses, Wall Cranes and Electric Traveling Cranes, of which we will be glad to send catalogues.



A Hard-Hitting Nine in the Production League

WHEN it comes to scoring high in the daily output sheet, this hammer team of the Llewellyn Iron Works, Los Angeles, is there with the wallop.

Whether a smashing hit or a gentle "bunt" is signalled, the hammer responds with equal exactness and precision.

—It's a Bement

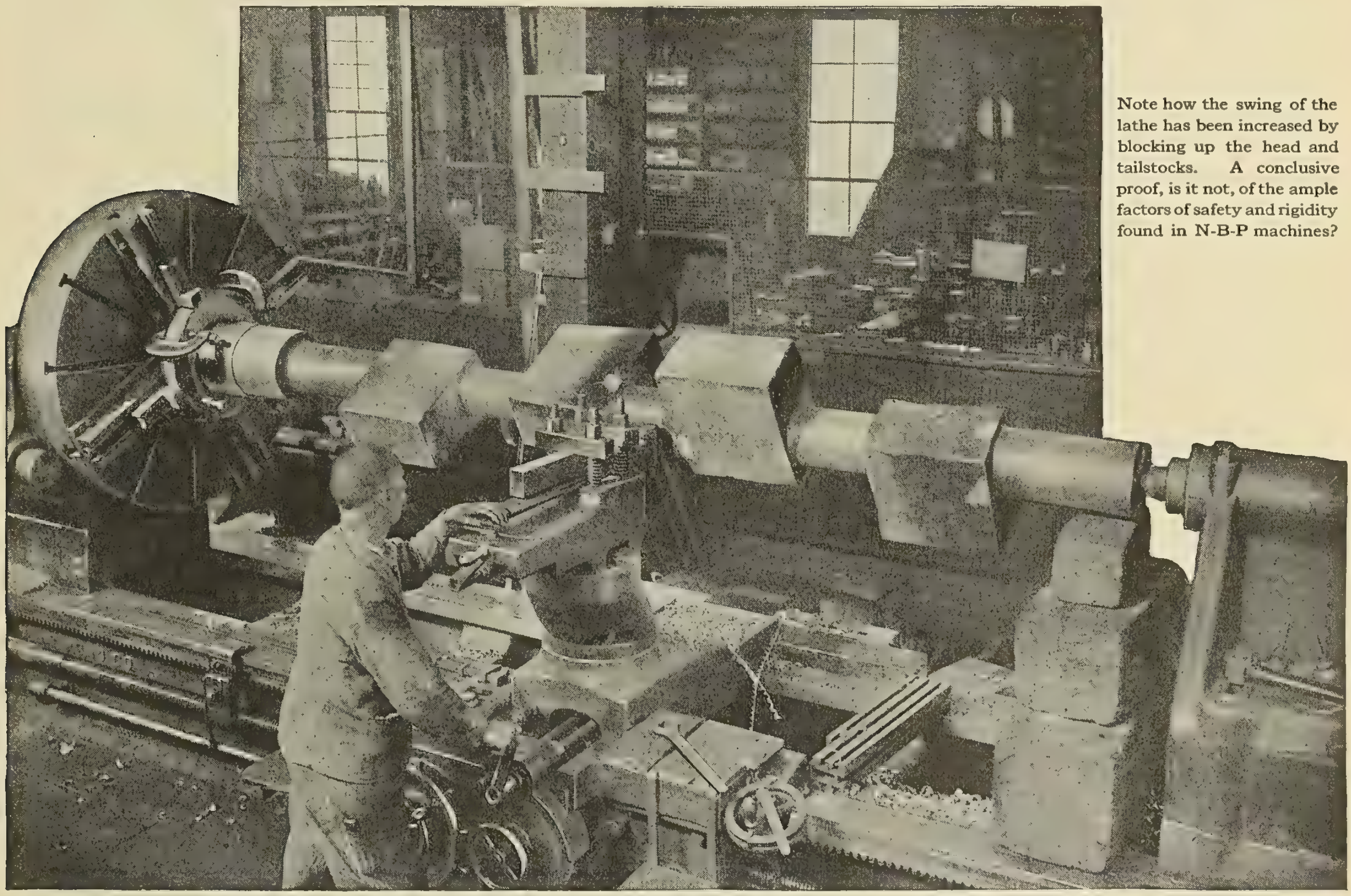
NILES-BEMENT-

GENERAL OFFICES:

In the Machine Shop

ON this page is shown one of the N-B-P specialties, the Heavy Engine Lathe, used extensively for crank shafts, line shafts, thrust shafts, tail shafts and similar work. A lathe handling this work must withstand the severe strains put upon it, taking, as it does, the initial cut on rough forgings just as they come from the forge shop. The proof that N-B-P Lathes fill the bill in this respect lies in an unbroken record in the long established ship and engine works on both coasts. The installation shown on this page is doing duty in the Skandia Pacific Oil Engine Company's works at Oakland, California.

IN marine engine and machine shops, big work is the rule. The day's work includes crank shafts, rudder posts, rudder stocks and the large castings that make up the completed engine, comprising beds, cylinders, connecting rods, guides and valve gear. These units require heavy, well-designed machine tools. N-B-P Lathes, Planers and Boring and Turning Mills have always been designed with the purpose in view of having ease of operation just as pronounced in heavy models of the machines as in the lighter ones.



Note how the swing of the lathe has been increased by blocking up the head and tailstocks. A conclusive proof, is it not, of the ample factors of safety and rigidity found in N-B-P machines?

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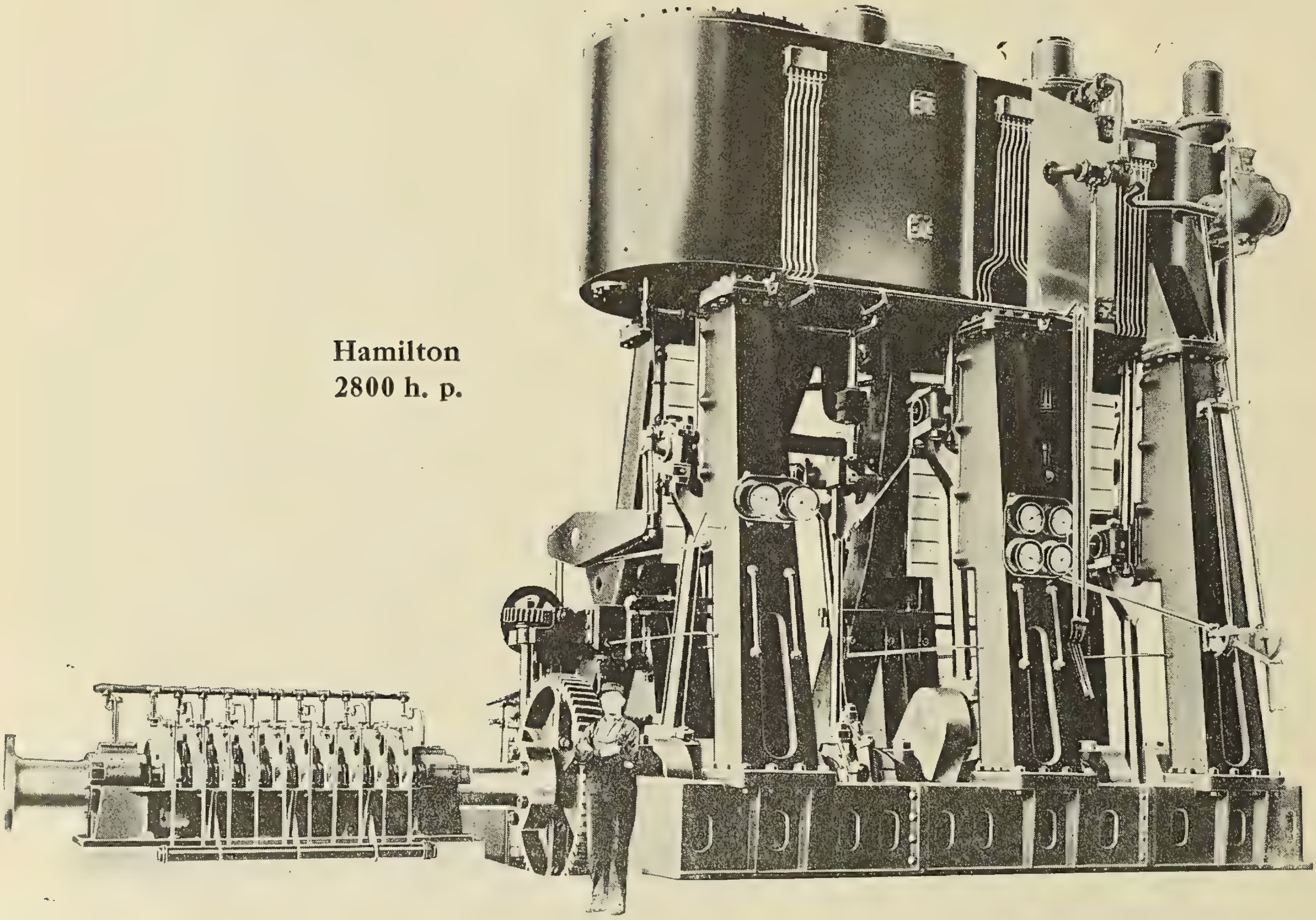
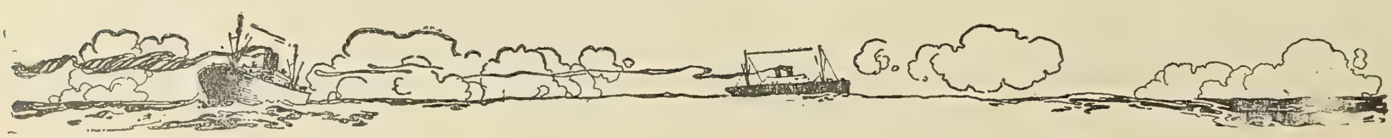
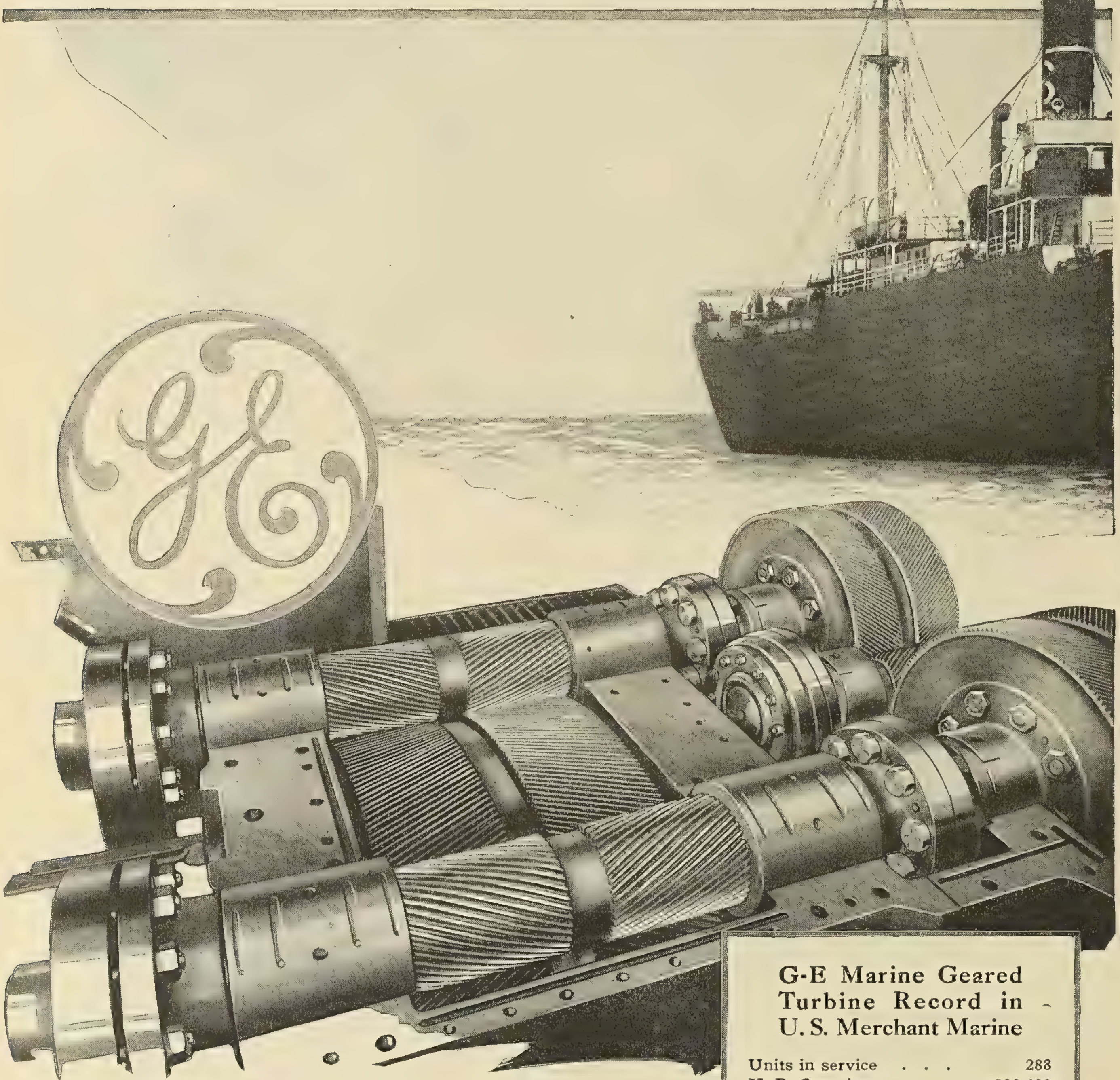
MARINE
500 TO
5000 H.P.



Hamilton
2800 h. p.



Consistent performance day in and day out, in storm and in calm is a requirement which good ship power must meet



Type of gear so successful on this ship—cover removed.

G-E Marine Geared Turbine Record in U. S. Merchant Marine

Units in service . . .	288
H. P. Capacity . . .	829,100
D. W. Tonnage . . .	2,588,529
Miles traveled	16,780,000

This nation had 144 Marine Geared Turbine vessels in service during the war—G-E equipment on 95 gave 81 per cent of the total service.

GENERAL

Only a few left

If you have not already received a copy of the "Ramsay Catalog" write for one to-day as we have only a few left.

We shall be glad to meet you at the Second National Marine Exposition, Grand Central Palace, New York—during the week of January 24th, 1921.

Our exhibit will be in Booths 34 to 41.

CHAS. CORY & SON INC.

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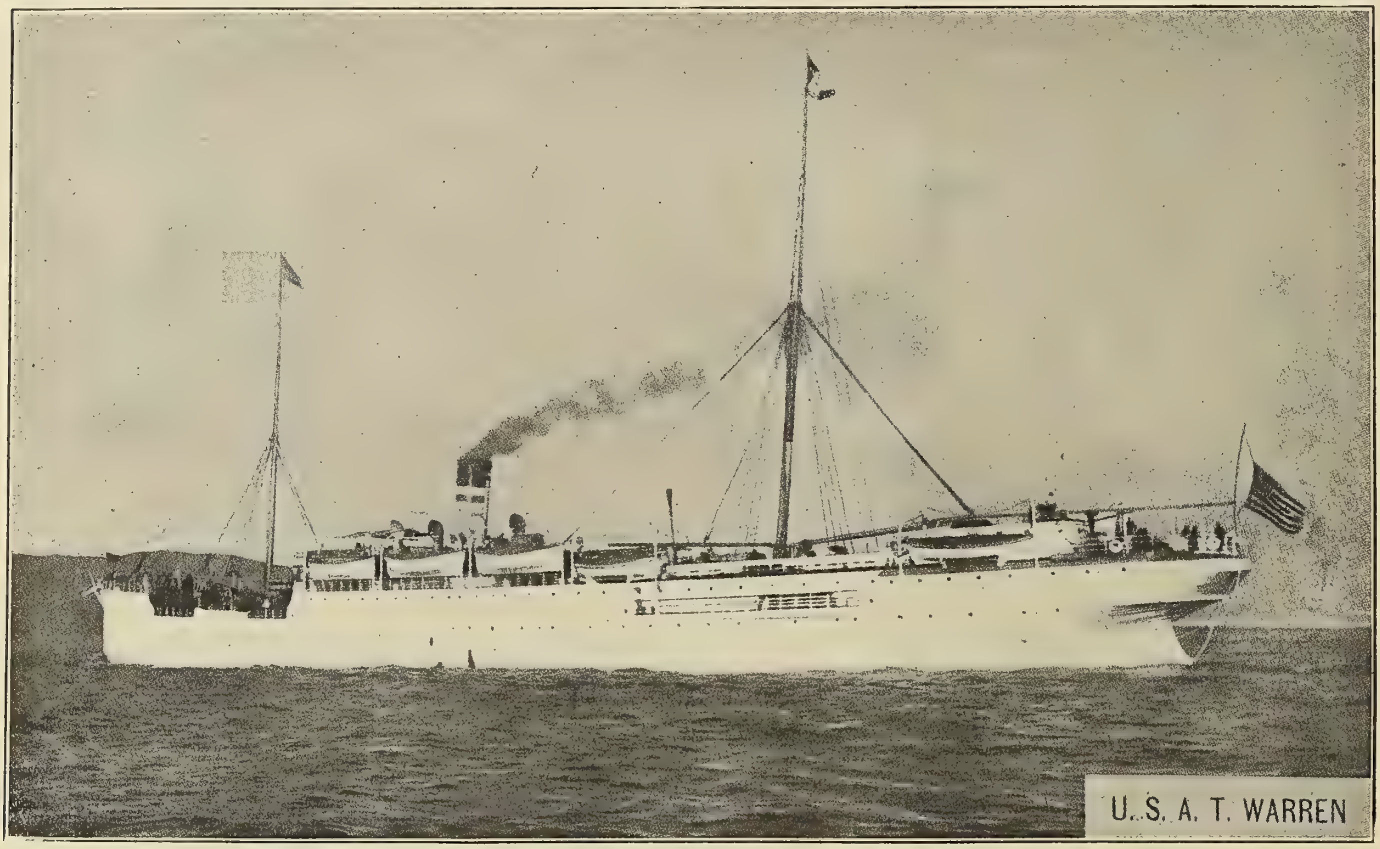


U. S. A. T. WARREN

U. S. Army Transport
"WARREN"

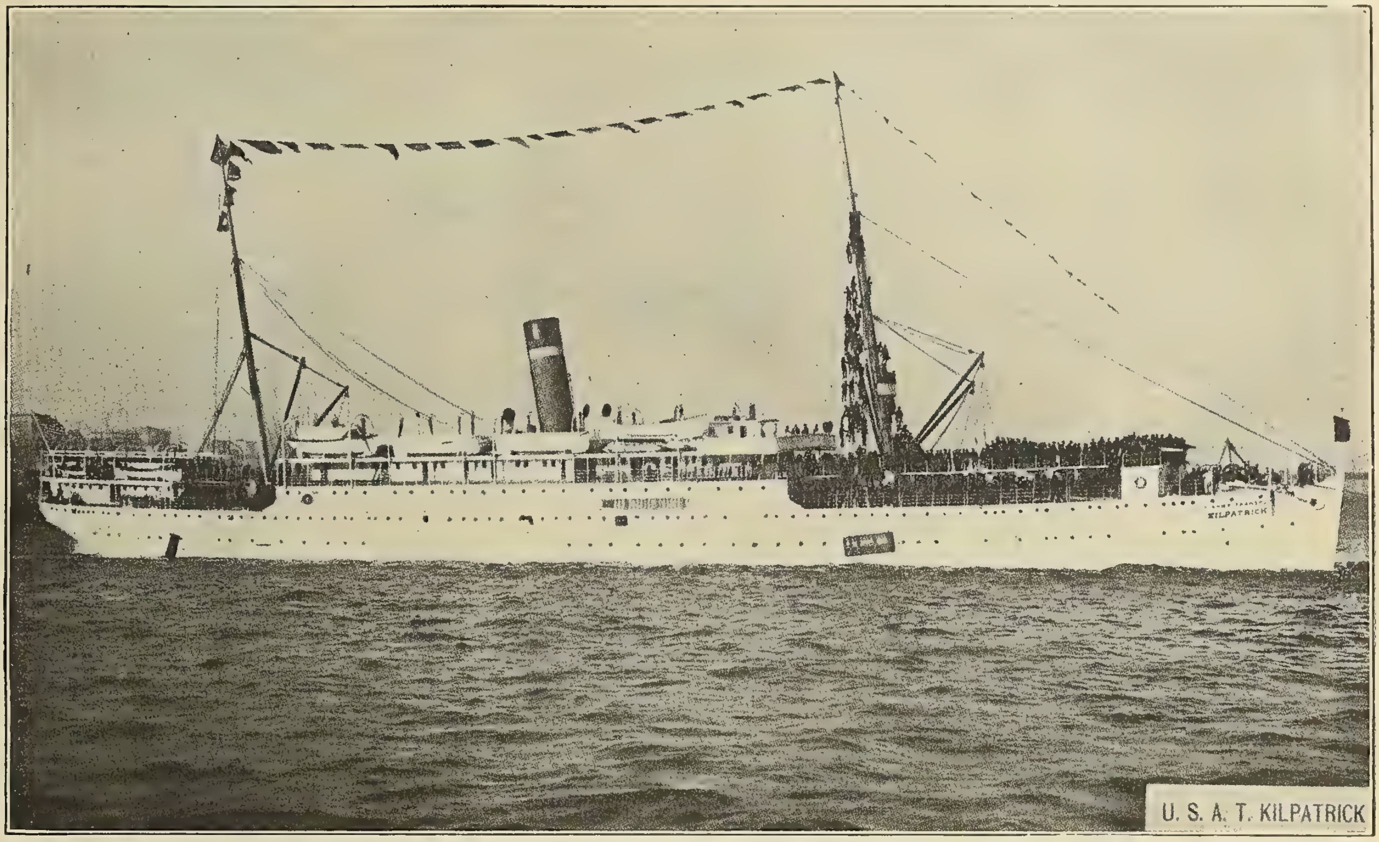
4234 Gross Tons.

Equipped and ready to sail.

Steel hull, double bottom, two masted schooner rig, one funnel. Formerly the German S. S. "Scandia" of the Hamburg-American line. Built in 1889. purchased by the War Department in 1898, extensively altered in 1899. Overhauled and repaired in 1901, re-conditioned in 1914. Three decks, three island type of superstructure. Water ballast, 555 tons. Triple expansion engines of 2200 I. H. P. Single bronze bladed screw. Babcock XX and Wilcox water tube boilers, new 1914. Speed, 11 knots. Original rating, Lloyds 100 A-1. Complement, 10 officers, 138 crew. Capacity—Fresh water, 114 tons. Bunkers, 1593 tons. Daily consumption, ordinary, 52 tons; high speed, 56 tons. Steaming radius, 5800 miles. Passengers: first class, 48; troops, 386. Cargo, 2910 tons. No troops or steerage, 3890 tons. Location, Manila Harbor. Will be delivered at U. S. port if desired and so stated in sales contract. Write for booklet giving full details.

THESE ships are particularly well suited for Pacific Coast and Alaskan trade, either as freighters or as combination freight and passenger carriers.

Moderate in size, obtainable at an attractive price, requiring only minor overhauling, and kept in profitable service at a relatively low operating cost, these ships will prove a remunerative investment. They can be used to successful advantage in the South American trade.



U. S. A. T. KILPATRICK

ALL vessels have full marine equipment—except for navigating instruments, which are not included in the sales. They are completely outfitted for passenger service.

Included in the equipment are steward's fittings, napery, silverware, galley equipment, boatswains' stores, general supplies, life boats and launches, life belts and rafts, military standees for the steerage, evaporators and distillers, and many other items.

U. S. Army Transport "KILPATRICK"

Formerly the British S. S. "Michigan," built in 1890 at Belfast, Ireland, by Harlan & Wolf. The "Kilpatrick" is a schooner rigged ship of 5045 gross tons, ready to travel under her own steam; her hull is of steel, and single bottom, and in fair condition throughout. Also is equipped with Scotch Marine boilers and single screw, triple expansion engine of 2300 I. H. P.

U. S. Army Transport "CROOK"

Was built in Scotland by Murry and Company in 1882, and operated as the S. S. Roumania under British registry.

This boat is of schooner rig, steel hull, single bottom construction, and 4,126 gross tons. This vessel is ready to steam under her own power at from 10 to 13 knots an hour. Her cargo capacity is 4,188 tons with 10,800 cubic feet of cold storage.

Was reconditioned in 1915 and fitted with large hatches for service under the Alaska Railway Commission. Well suited for West Coast Trade.

United States Army Transports for Sale

In addition to the three transports named on the preceding pages, the following, which are in service at present, will be placed on sale at a later date.

"BUFFORD"—Sister ship to Kilpatrick		5040 Gross Tons.
"SHERMAN"	These four are sister ships	5780 " "
"SHERIDAN"		5673 " "
"THOMAS"		5796 " "
"LOGAN"		5672 " "

Asst. Chief, U. S. Army Transport Service

Dept. D, Pier 2, Hoboken, N. J.

The "Warren," "Crook," and "Kilpatrick" may be inspected by interested parties at any time. Bids on these three vessels will be received at the above address up to 10 A. M. EASTERN STANDARD TIME, JANUARY 8, 1921. If you will tear off and mail this coupon, you will receive a booklet giving complete information regarding location of the ships (where they may be visited for inspection), their history, construction, deck plans, etc.

Note: This booklet, of course, will be mailed to responsible parties only.

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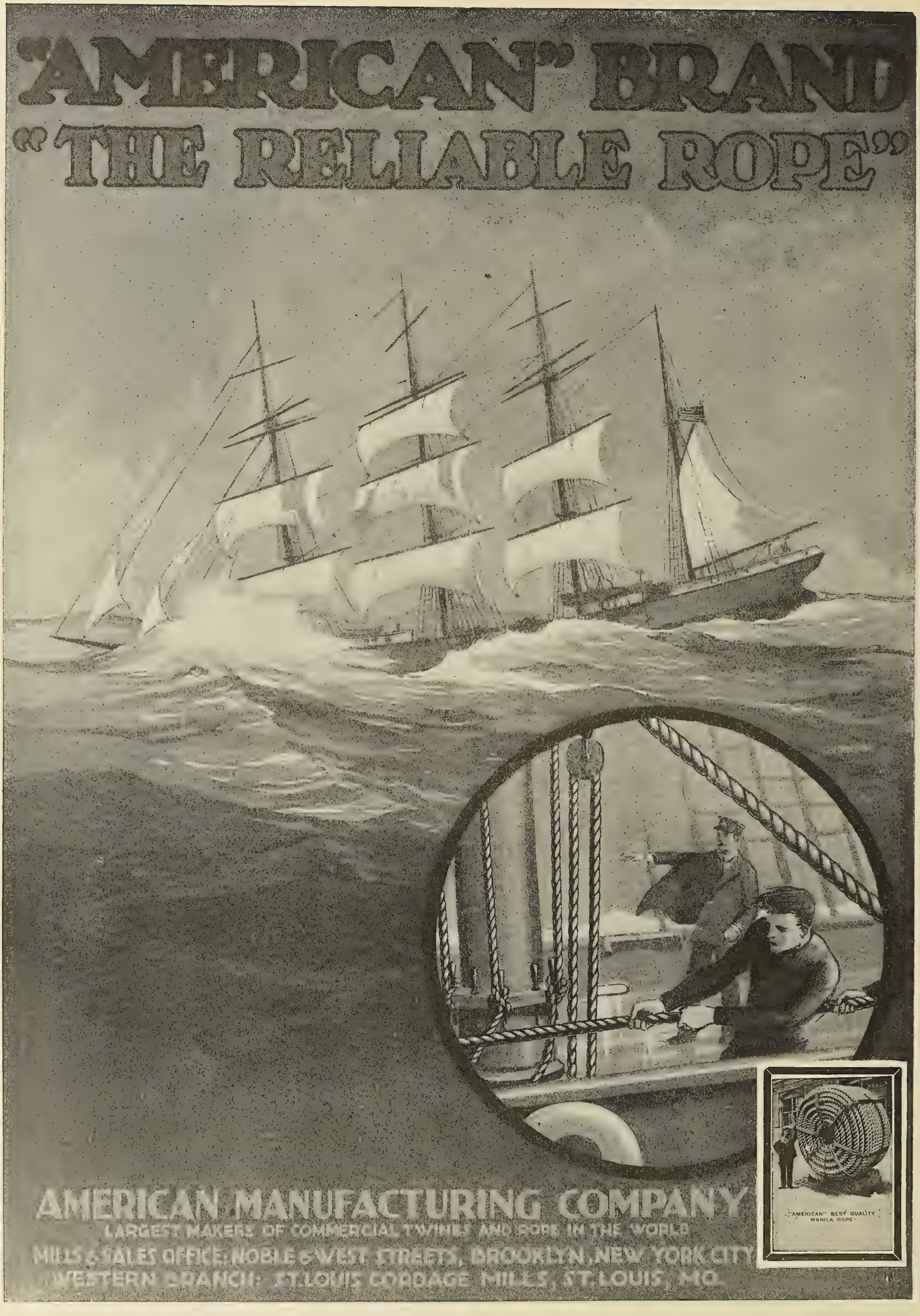
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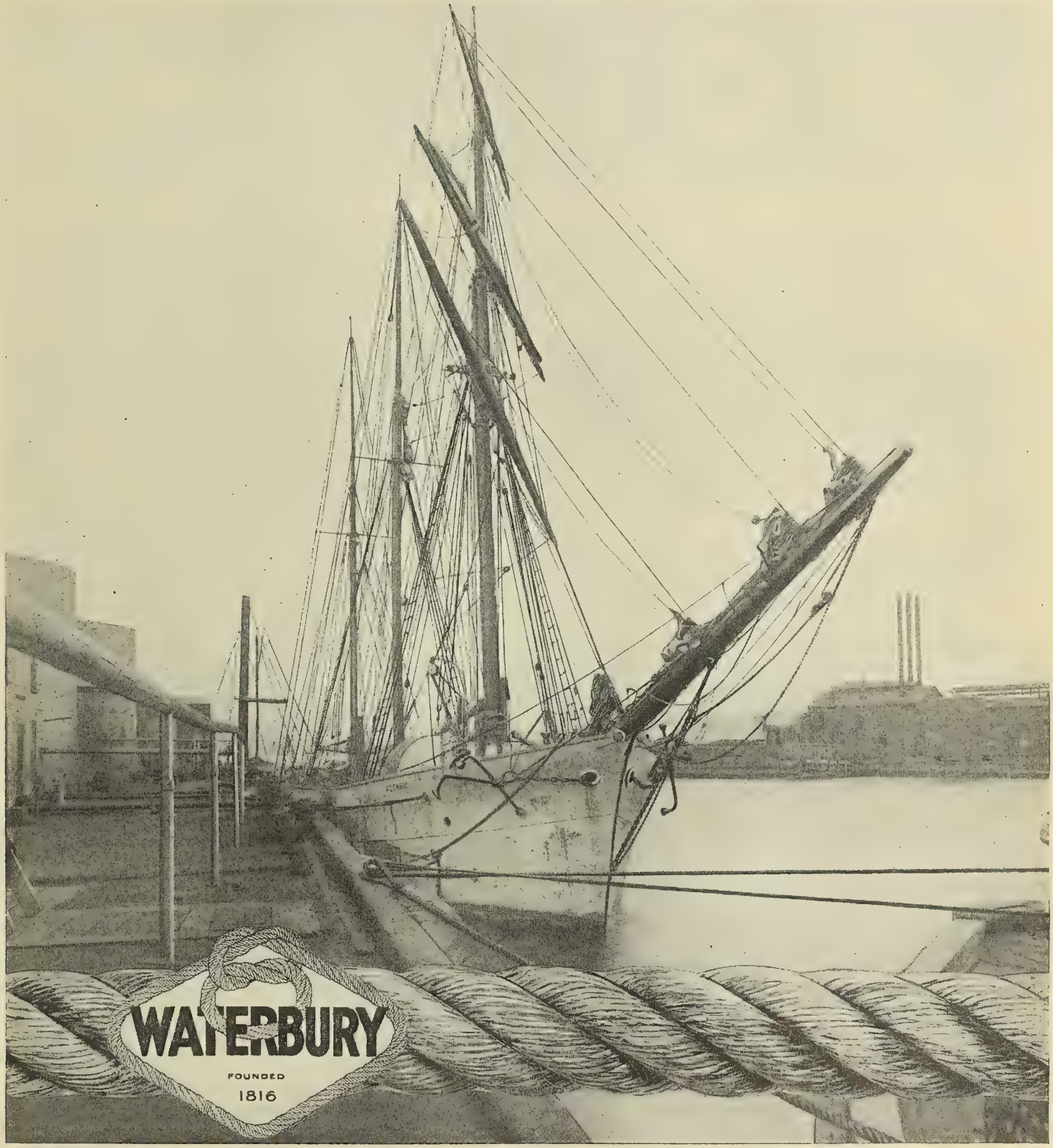

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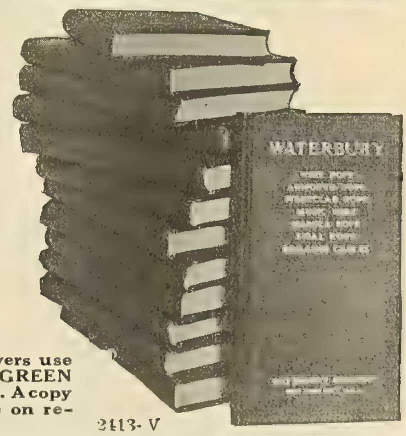

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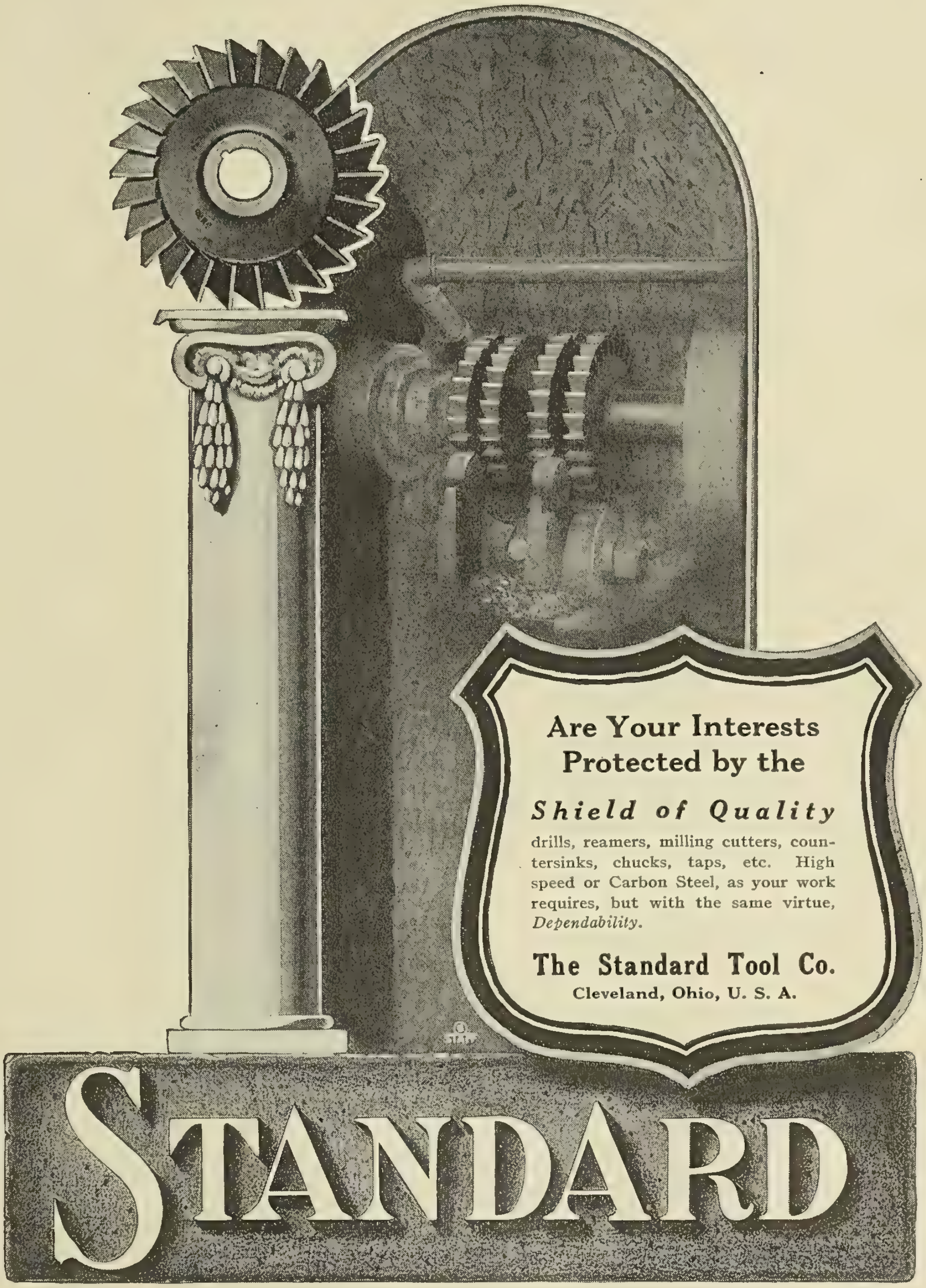
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drills, reamers, milling cutters, countersinks, chucks, taps, etc. High speed or Carbon Steel, as your work requires, but with the same virtue, *Dependability.*
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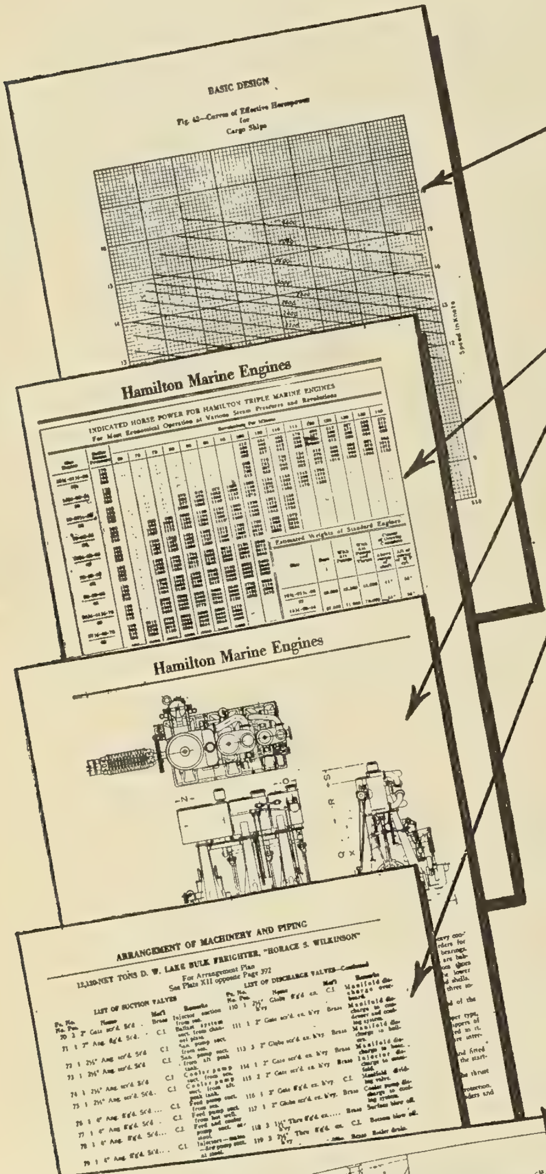

A specimen page from the Basic Design Section—Universal Power Curves—plotted on speed and length, which enable the Naval Architect or Chief Engineer to determine, by inspection, the effective horsepower required for a certain vessel. From these the size of engine is quickly determined.

Specimen Catalog pages on Reciprocating Engines. The table gives the horsepower of 17 sizes of engines at varying steam pressures and R. P. M.; with weights and centers of gravity of engine required. The outline drawing gives all essential dimensions.

Specimen pages from the Ship Plan Section. Just two of the many pages showing working drawings of machinery arrangements, piping plans with bills of material, etc., suitable for adaptation to new designs.

These few pages suggest the vast fund of practical information in the 1200 pages of the SHIPBUILDING CYCLOPEDIA. In the Text Sections is data invaluable for the planning of ships and yards—in the Catalog Section is just as valuable data on specific equipment of many leading manufacturers.

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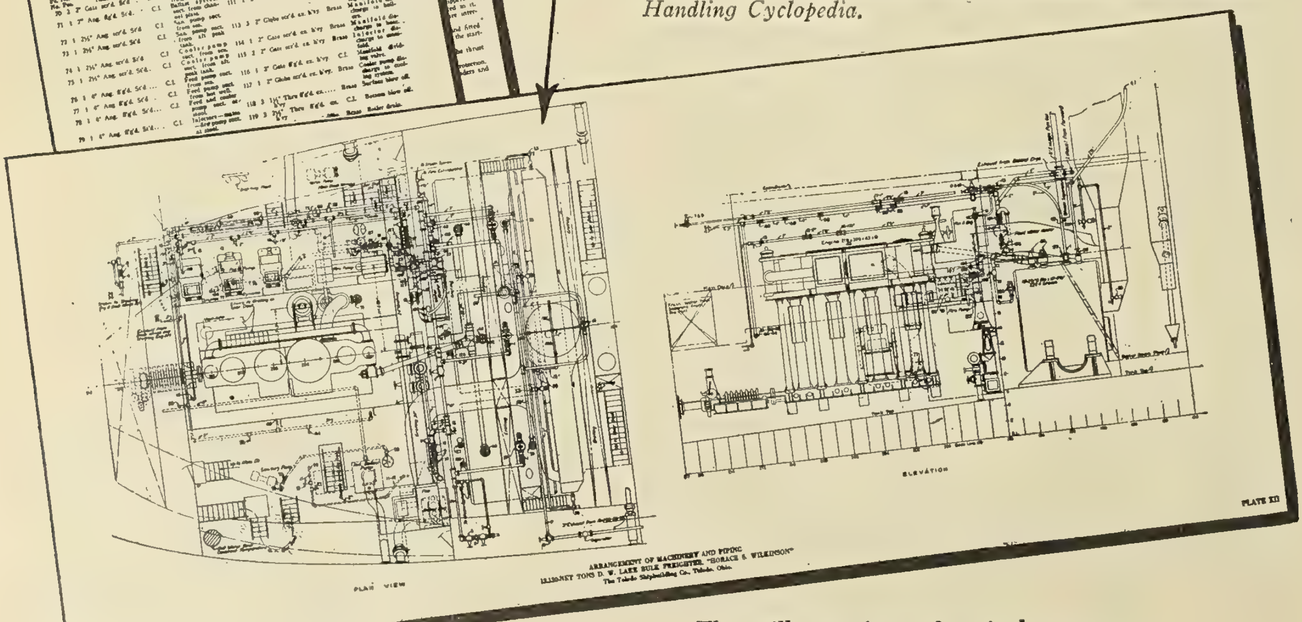

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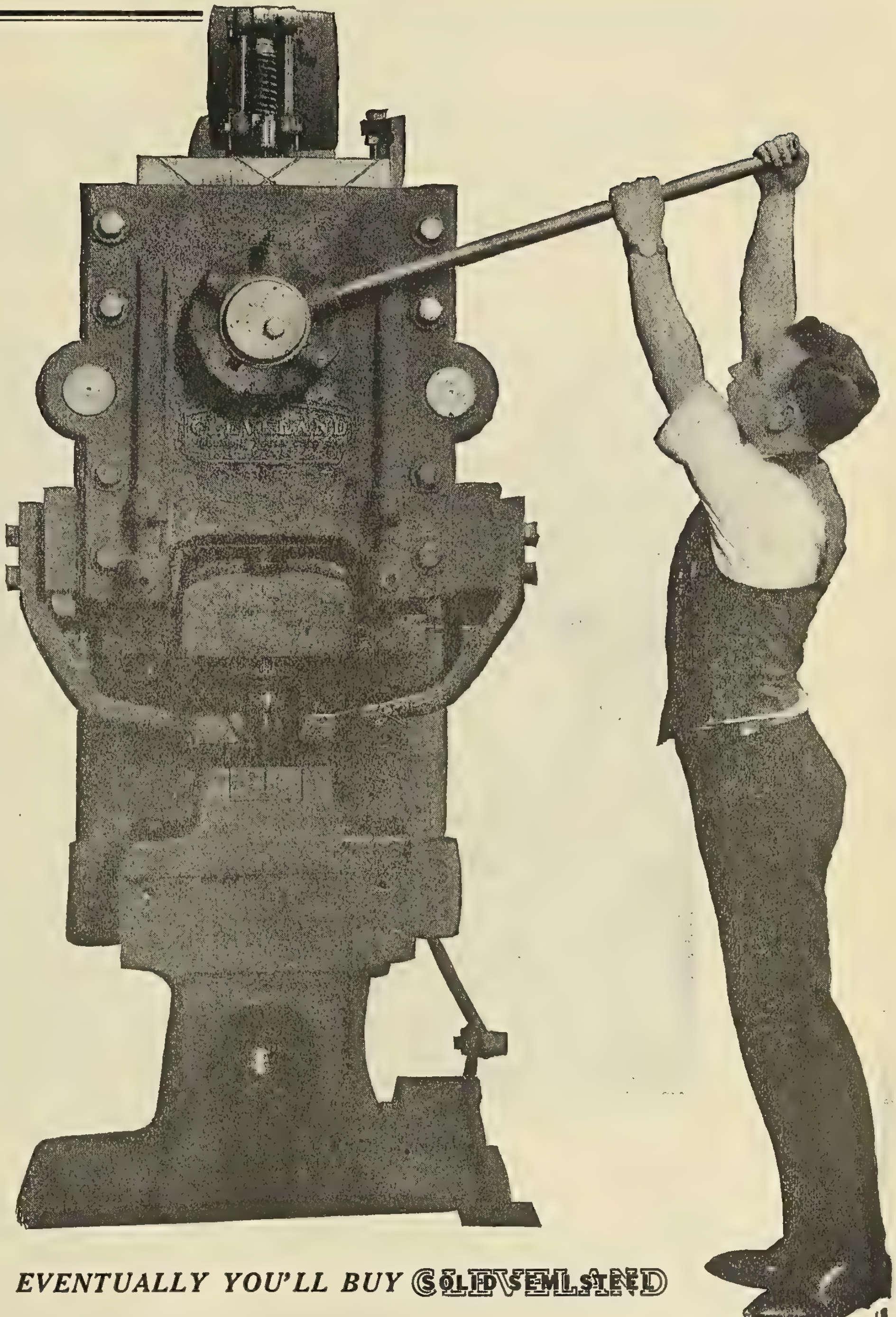

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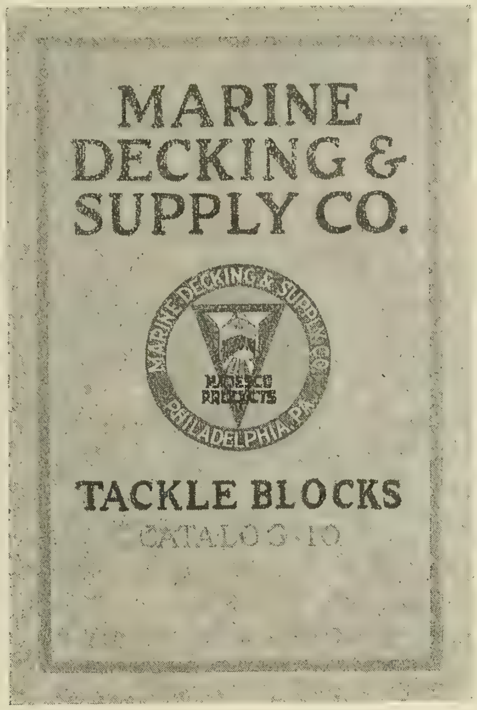

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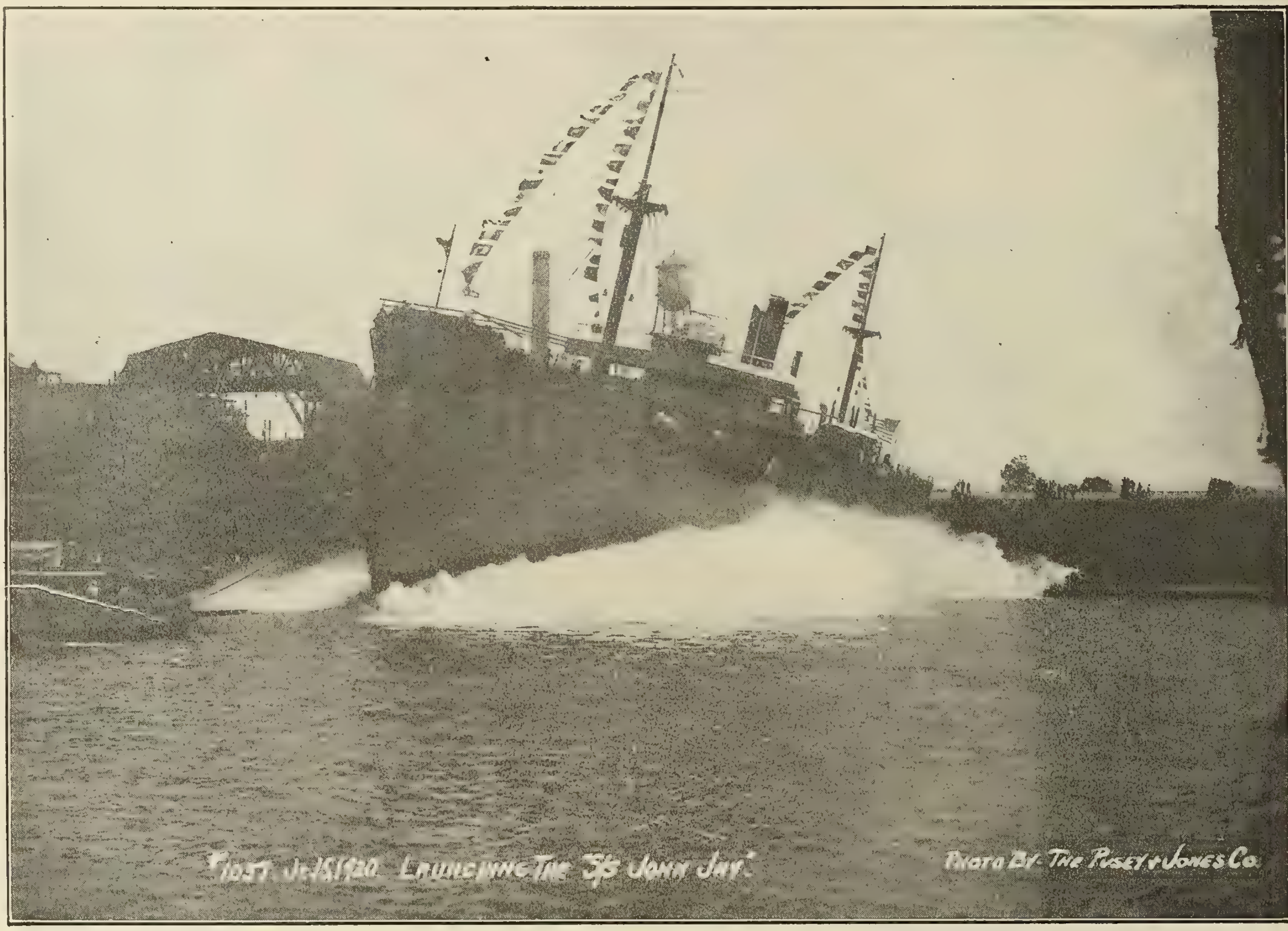
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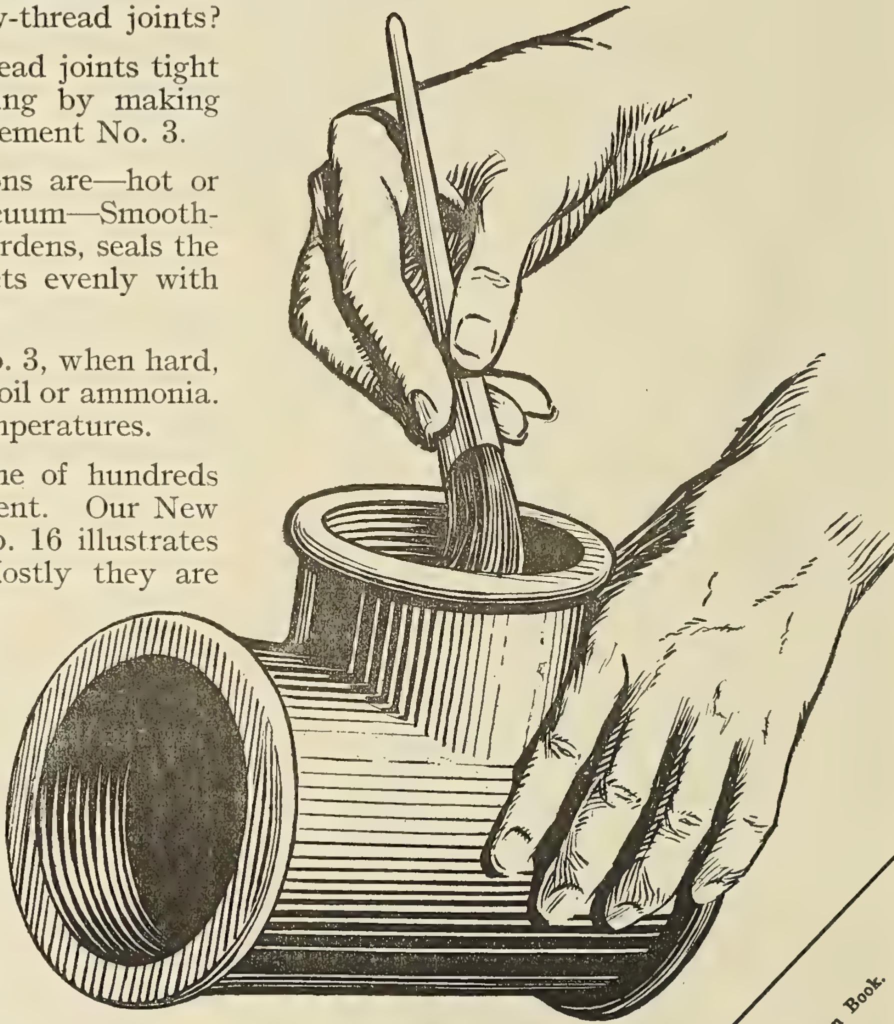

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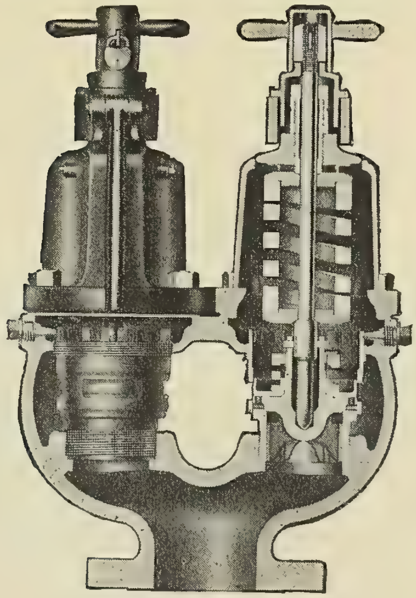

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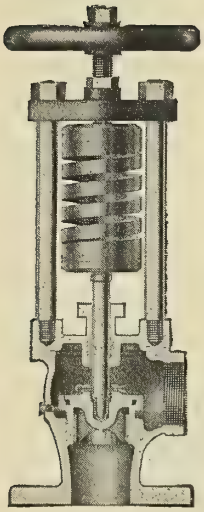

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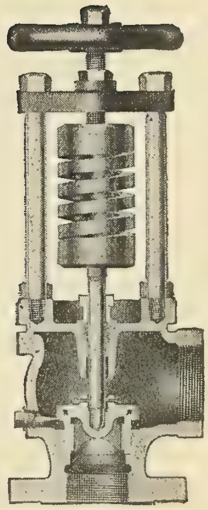

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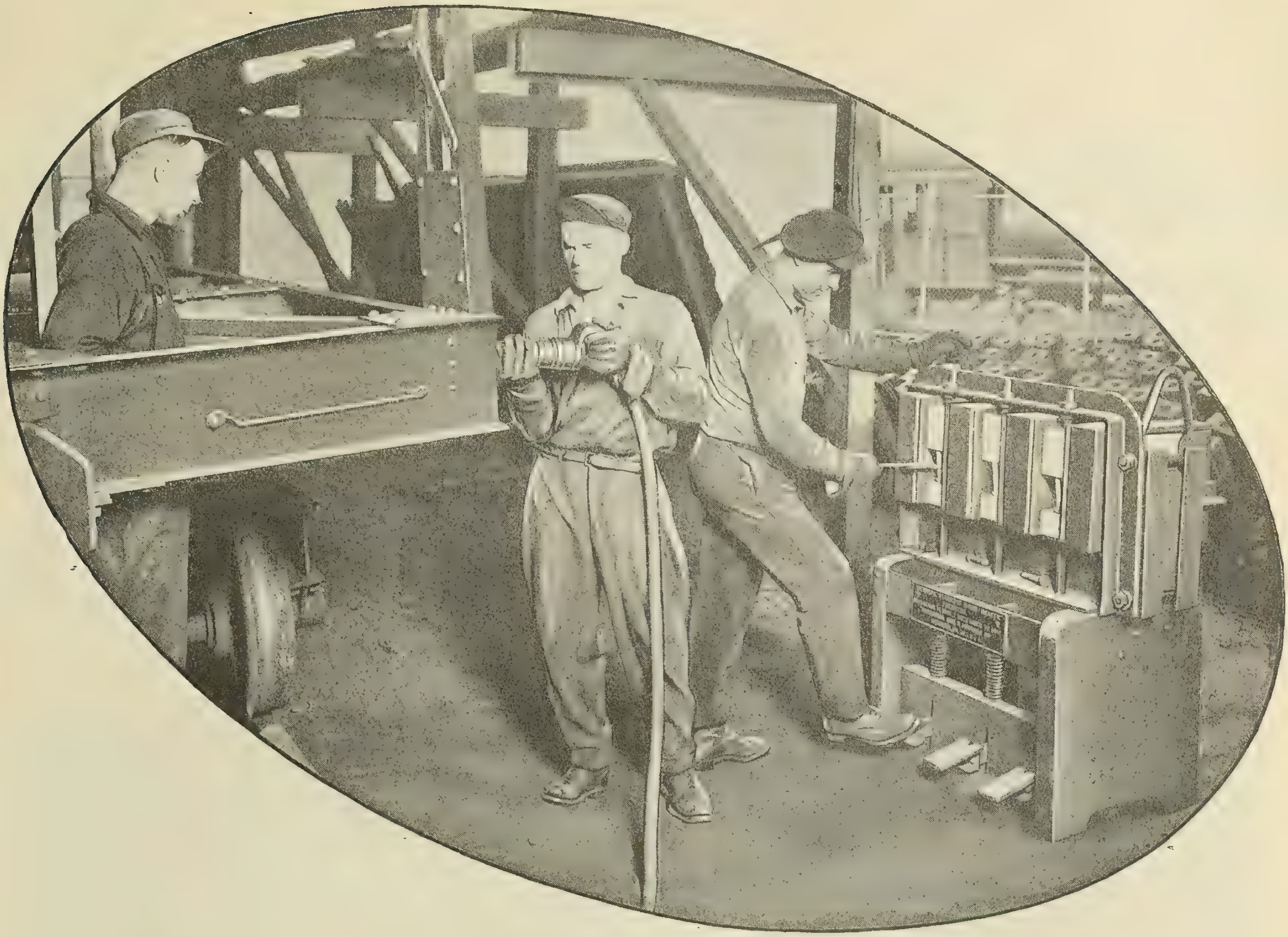

No Rivet Heating Waste Here

No waste of rivets. The boy (or girl) who operates the Berwick Electric Rivet Heater can **see** the rivets being heated. This prevents burning and scaling losses—a saving which averages 40 cents per hundred pounds of rivets heated.

No waste of power. The Berwick uses power only when actually heating rivets—less than 20 kilowatt-hours per hundred pounds of rivets heated. There is no waste of power when the machine is not operated at full capacity.

No waste of labor. Being conveniently portable, and free from smoke and fumes, the Berwick can be placed close to the work, thus eliminating much throwing of hot rivets and sometimes eliminating one boy from each gang.

No waste of time. The men are never kept waiting for hot rivets, for the Berwick will heat a rivet in from 20 to 30 seconds. This eliminates delays when starting work and is especially convenient when only a few rivets are required.

You will be interested in other Berwick features. Send for our catalog. Please mention the quantity and sizes of rivets you use and alternating current conditions.

American Car and Foundry Company

Chicago **165 Broadway, New York** **St. Louis**

BERWICK ELECTRIC RIVET HEATER

A diver being raised to the deck after a record-breaking descent in a steel suit weighing hundreds of pounds

When We Raid Davy Jones' Locker

A LEADING maritime expert has said that when the United States establishes a large merchant marine it must, to obtain reasonable insurance rates, maintain an efficient salvage division.

Salvage brings instantly to mind the diver. And the diver's life and efficiency rests almost entirely on the hose that brings him air. When you stop to consider that the pressure 280 feet below water is 130 pounds to the square inch, or approximately 270,000 pounds upon the entire body (the weight of a large freight locomotive), you can see why no end should be spared to get hose that is absolutely dependable.

Such hose is Goodrich Divers Hose. For a half-century we have been making hose—and no single piece is studied and worked with more care than divers hose. Not only does the best rubber and fabric go into it—but we incorporate a rubber vitality that assures the same safety after months of service as when first used.

Apart from our high standard grade, we build to specifications when asked.

Goodrich makes hose for all marine purposes

Goodrich Divers Hose

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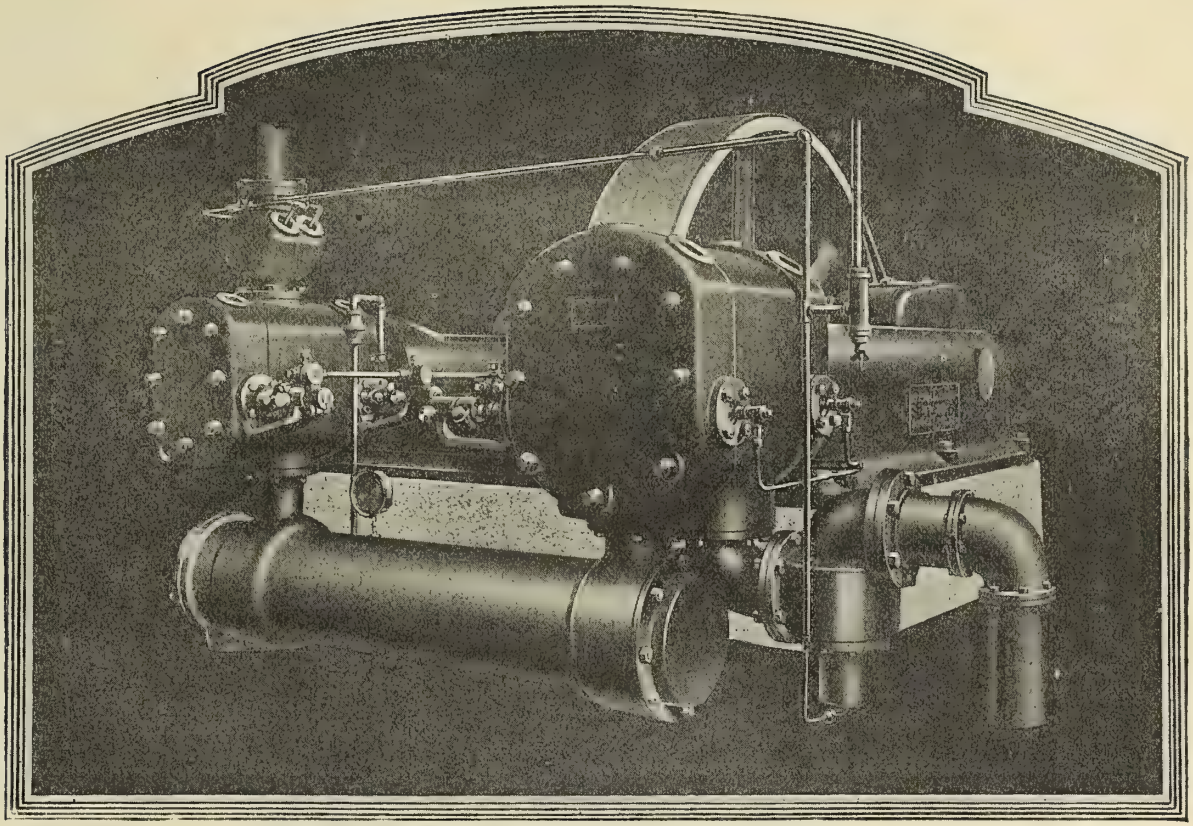

Does the cost price determine your air compressor selection, or have you decided from experience that low first price often means an expense, rather than an investment?

The air compressor should increase your production, reduce your manufacturing costs and help you realize a profit. It must be a machine you can afford to use—run when you need it and require the least possible attention.

Broken parts mean repair parts, lost running time and interruption. A cog is thrown into the wheels of progress and the compressor ceases to earn and becomes a troublesome expense.

The efficient compressor produces air at the least cost per cubic foot actually delivered, taking into account the costs of power, attendance and repairs. It is economical of floor space, without sacrificing accessibility or strength.

It has reliable regulation, so that the load is automatically on or off depending upon the demand for air. Lubrication is automatic and reliable but economical.

Such are Ingersoll-Rand Compressors. Also, in all I-R compressors—belt, steam or direct-connected electric drive—the driving medium is given equally careful attention.

For belt drven units of medium size it will pay you to look into the "Imperial" XB Compressors, shown in the above illustration. This is fully described in Bulletin No. 3312. Let us send you a copy.

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Whatever you pay, you waste fuel when your ships operate on saturated steam and waste is inexcusable when a practical means to save it is available. When ships operating on saturated steam are converted into the economical class by the application of Elesco Fire Tube Superheaters, a saving of upwards of 15% in fuel is realized. With coal at $22.00 a ton, this represents a saving of $3.30 a ton, or $3,300 on a 1000 ton bunker capacity.

Fire Tube Superheaters may be installed while the ship is in port taking cargo.

More cargo space is available on ships equipped with Fire Tube Superheaters, because less **bunker space is required.** Less fuel in bunkers means less weight of fuel to be carried.

Our Bulletins explain the advantages of high degree superheat—advantages which have been considered worth while in over 2000 ships.

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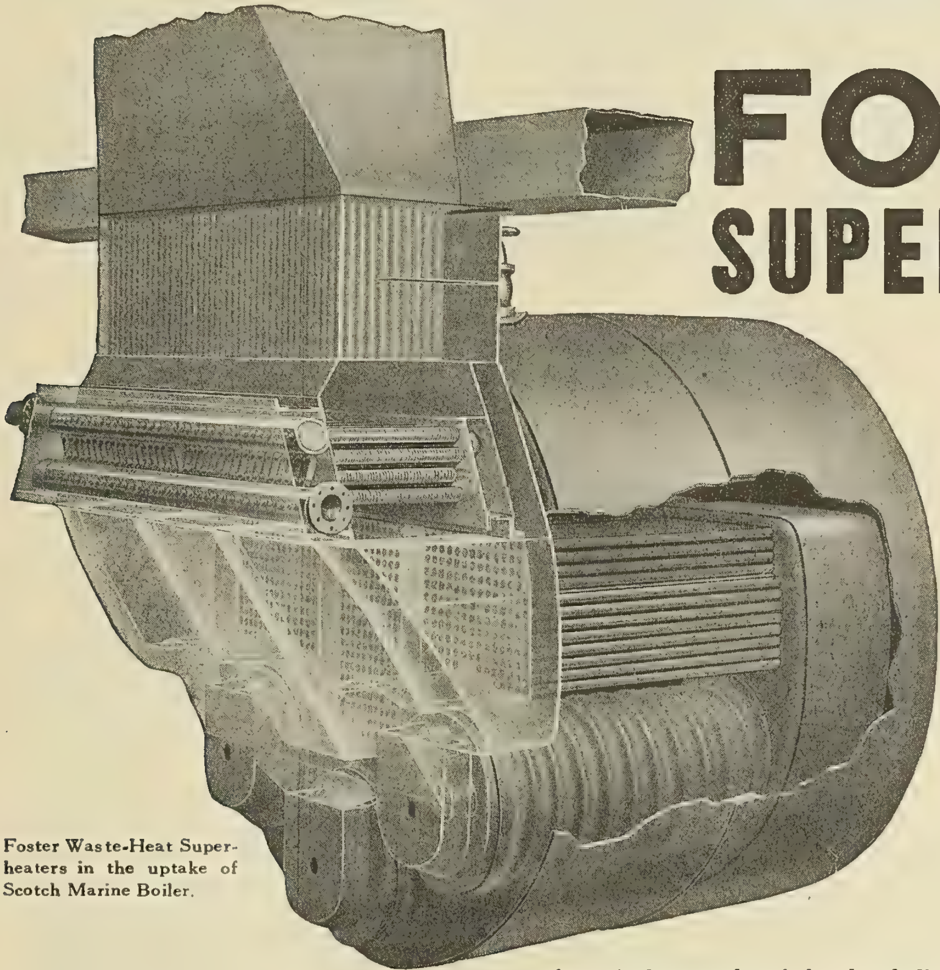

Foster Waste-Heat Superheaters in the uptake of Scotch Marine Boiler.

The experience of one operating engineer with

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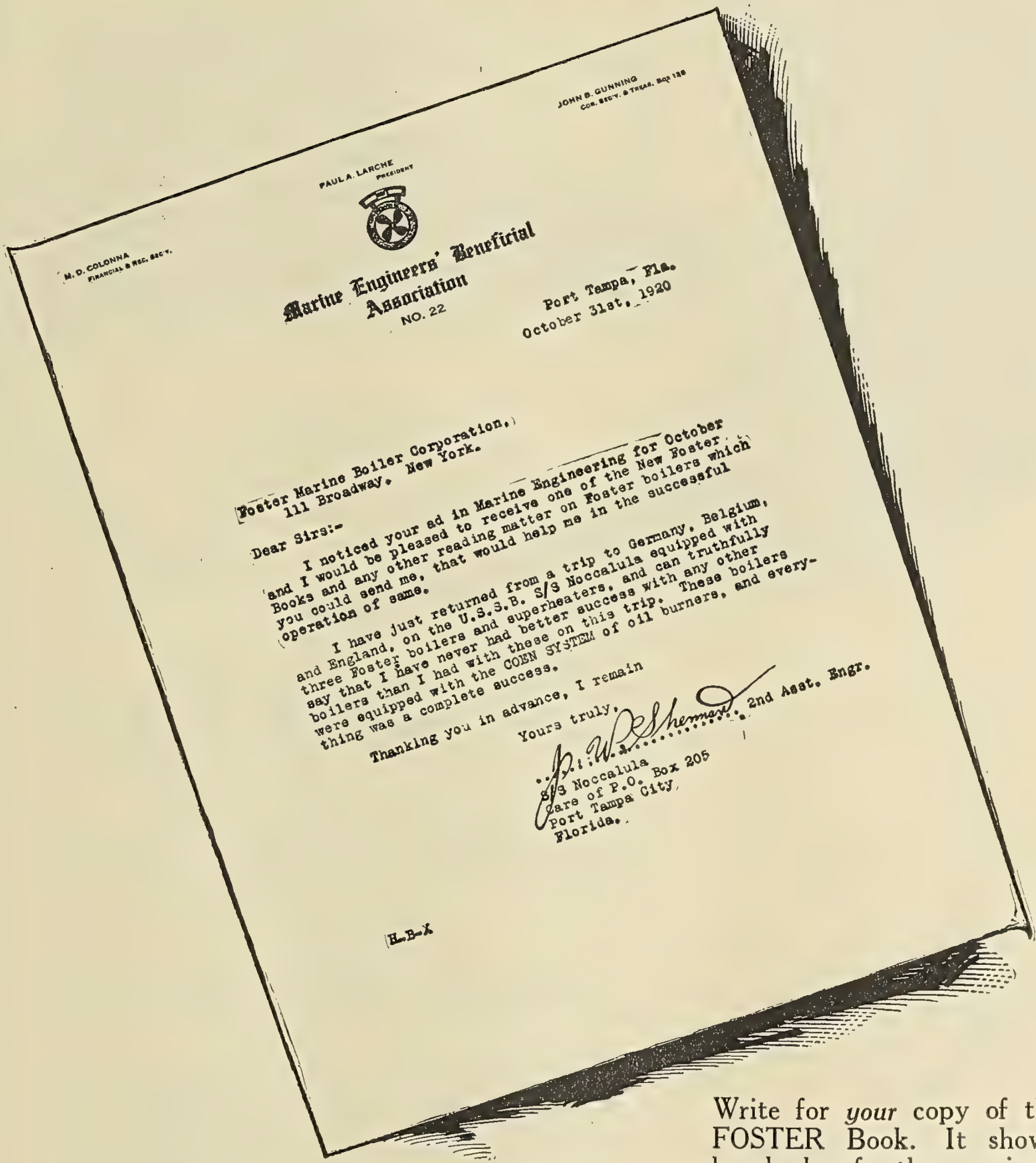

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Marine Engineers' Beneficial Association
NO. 22

Port Tampa, Fla.
October 31st, 1920

Foster Marine Boiler Corporation,
111 Broadway, New York.

Dear Sirs:-

I noticed your ad in Marine Engineering for October and I would be pleased to receive one of the New Foster Books and any other reading matter on Foster boilers which you could send me, that would help me in the successful operation of same.

I have just returned from a trip to Germany, Belgium, and England, on the U.S.S.B. S/S Noccalula equipped with three Foster boilers and superheaters, and can truthfully say that I have never had better success with any other boilers than I had with these on this trip. These boilers were equipped with the COEN SYSTEM of oil burners, and everything was a complete success.

Thanking you in advance, I remain

Yours truly,

2nd Asst. Engr.

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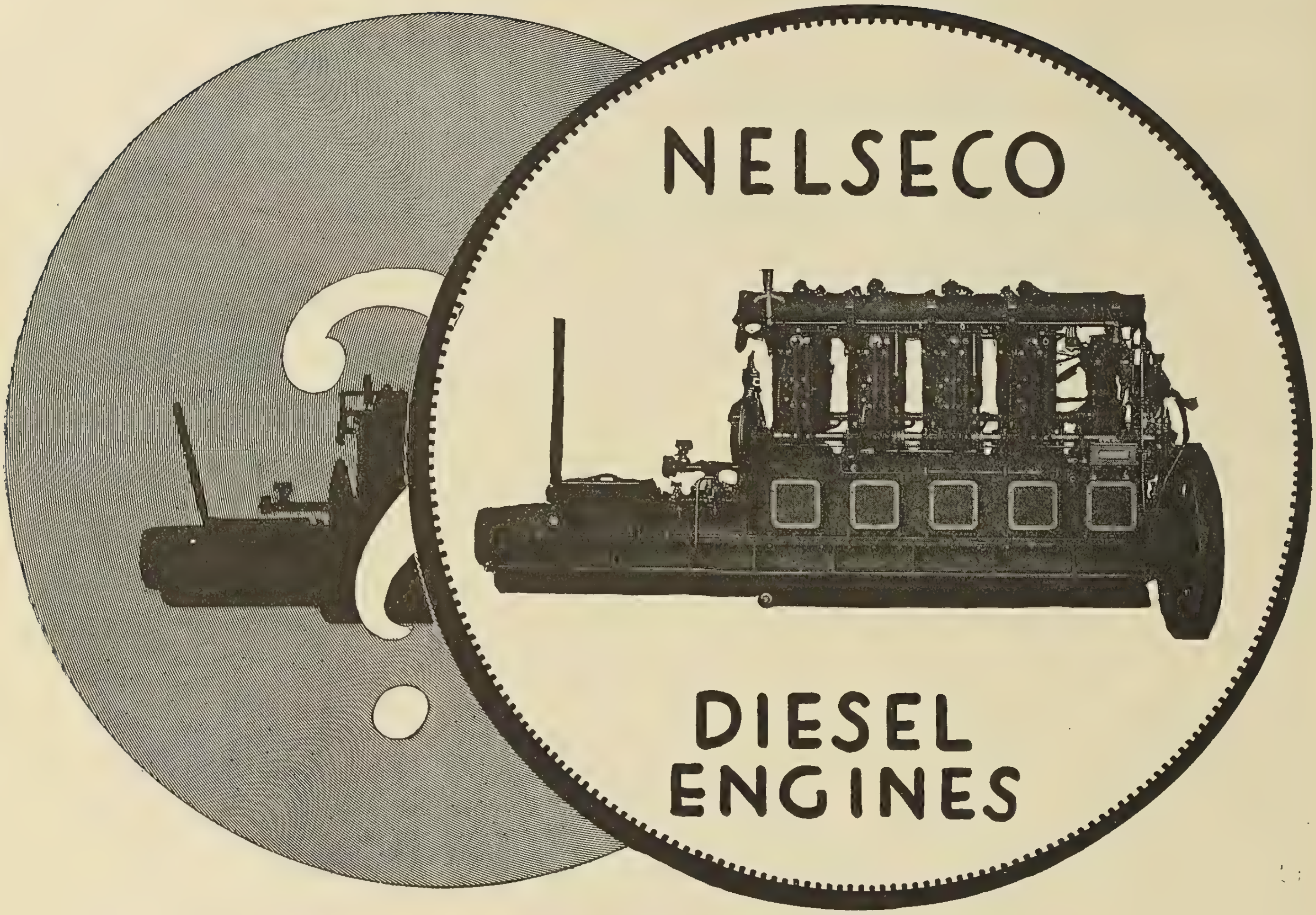

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NEVER ENTERS THE MIND OF USERS
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MARINE DIESEL ENGINES**

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HIGHEST AWARD
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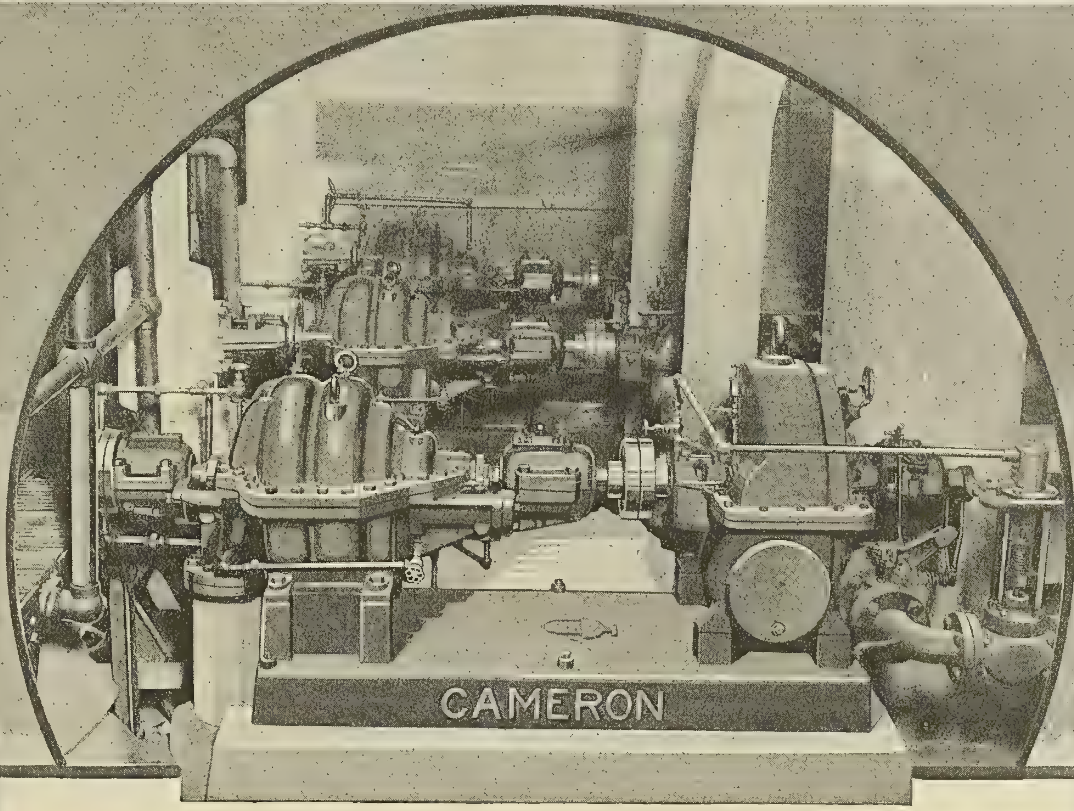
Ships thus equipped are propelled efficiently and dependably with as low fuel consumption as is possible to secure through any like operation. Over 150,000 H. P. now in service in American and Foreign Vessels or on order.

Sizes: 120, 180, 240, 360, 480 to 2000 B.H.P.

NEW LONDON SHIP & ENGINE CO., Groton, Conn., U. S. A.



The initial cost is only one item in the determination of pump expense.

Accurate records over a period of years, showing initial and upkeep cost, power consumed, and expense of lost operating time, conclusively demonstrate economy of Cameron Pumps.

For true economy specify Camerons.

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CAMERON PUMPS

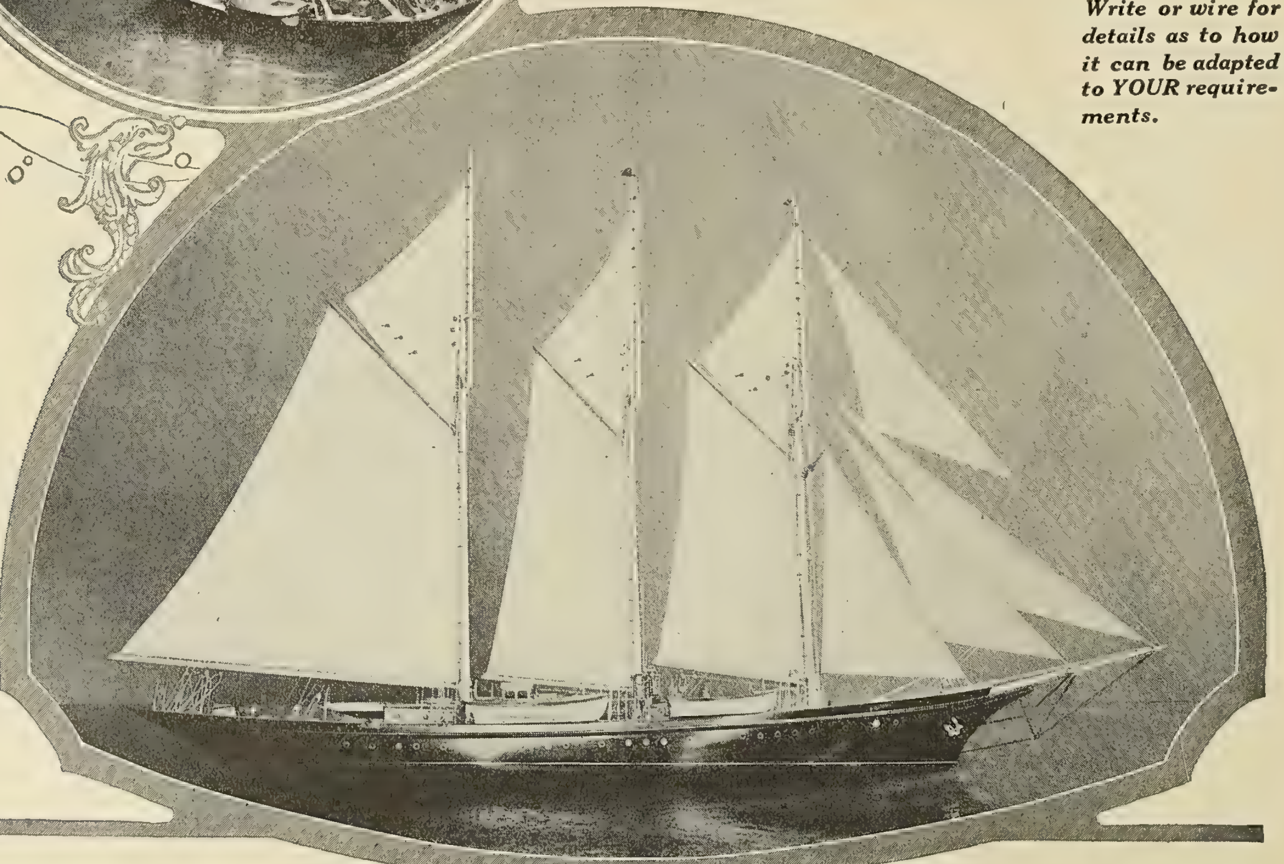
Another Winton Diesel-Electric Drive

Mr. Edgar Palmer's new "Guinivere" is equipped with a pair of six cylinder 13″ x 18″ Winton Diesel Engines, each direct connected to a 225 K. W. Westinghouse Generator, which in turn supply electric power to a 550 H. P. electric motor installed in the stern, giving the boat a speed of 11½ knots under power.

"Guinivere" was designed by A. Loring Swasey, constructed by Geo. Lawley & Son Corp., and is the largest fore and aft Auxiliary Schooner Yacht ever built, 195′ O. A. 52′ 5″ Beam. 15′ Draft.

This system of Winton Diesel Electric Drive is becoming increasingly popular.

Write or wire for details as to how it can be adapted to YOUR requirements.



WINTON ENGINE WORKS, = = = = = = = = Cleveland, Ohio

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Chisholm-Moore

Hoists Cranes Trolleys

Only Two Men on the Job

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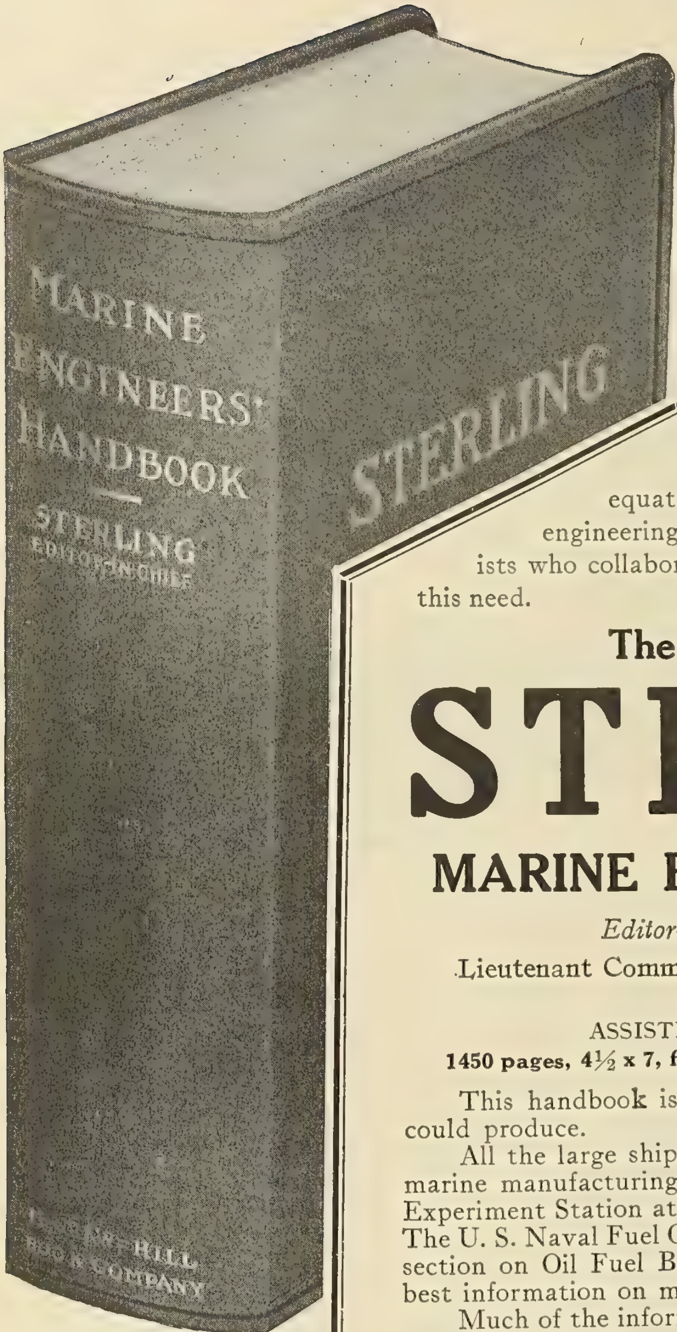

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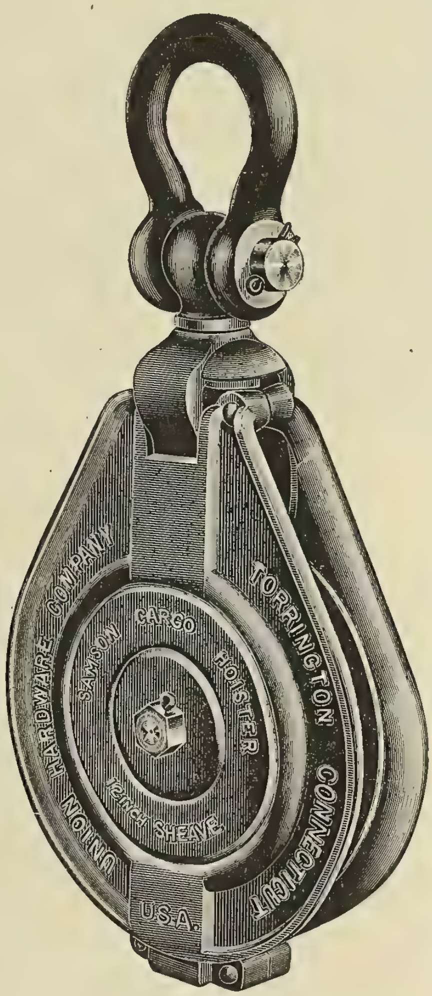

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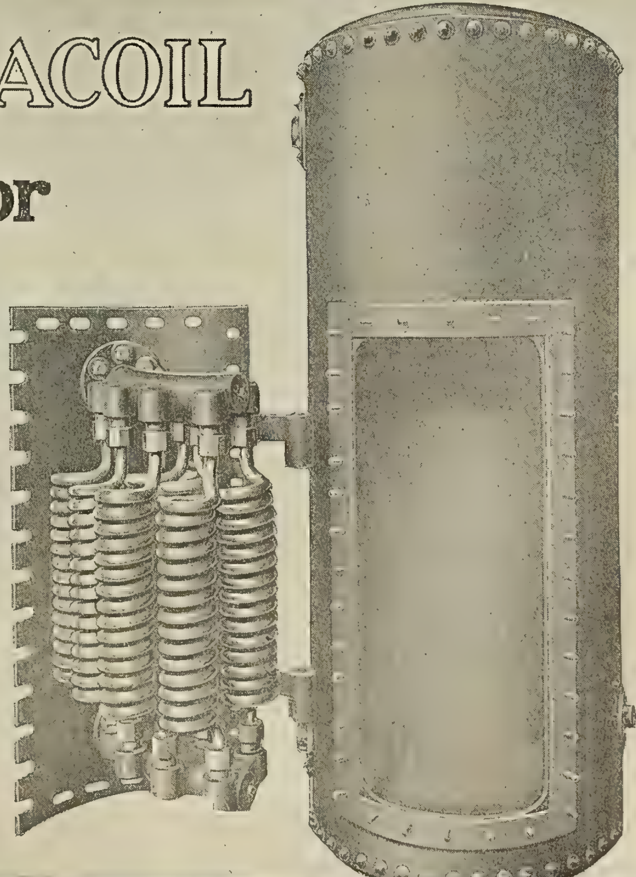

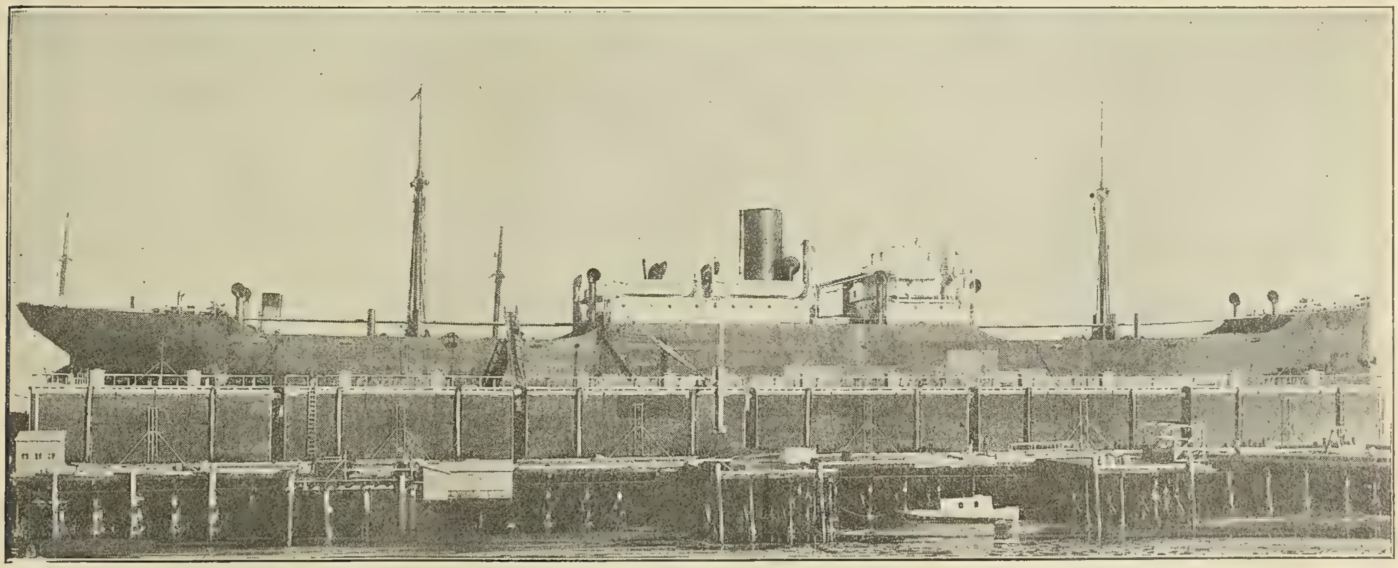

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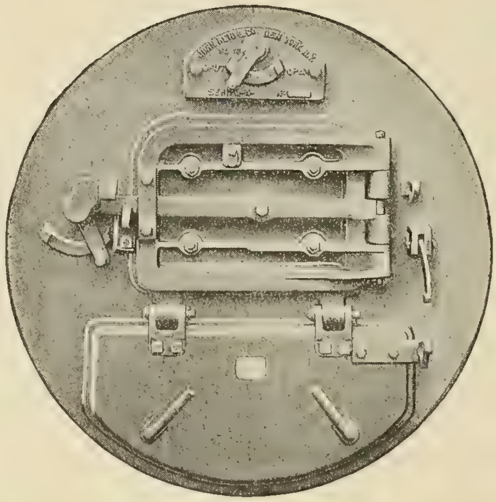

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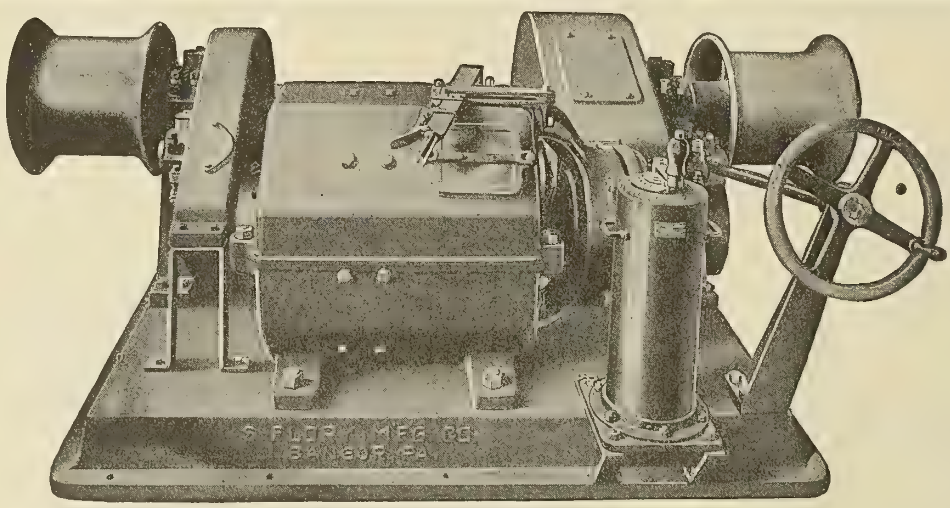

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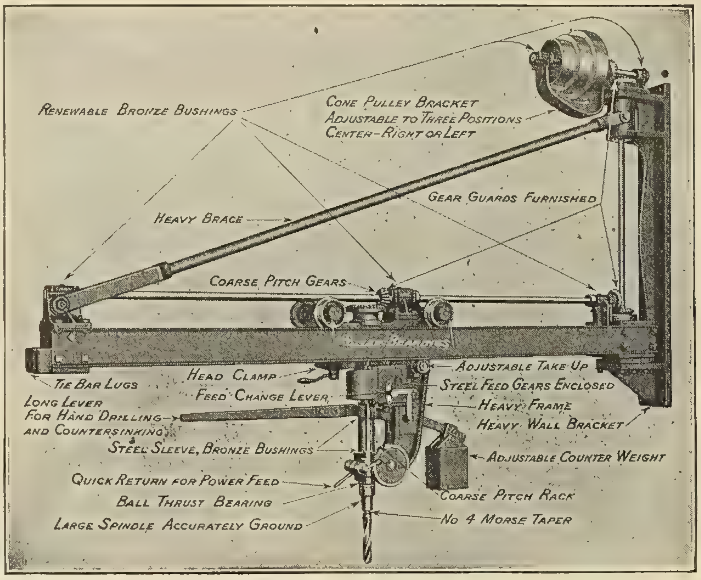

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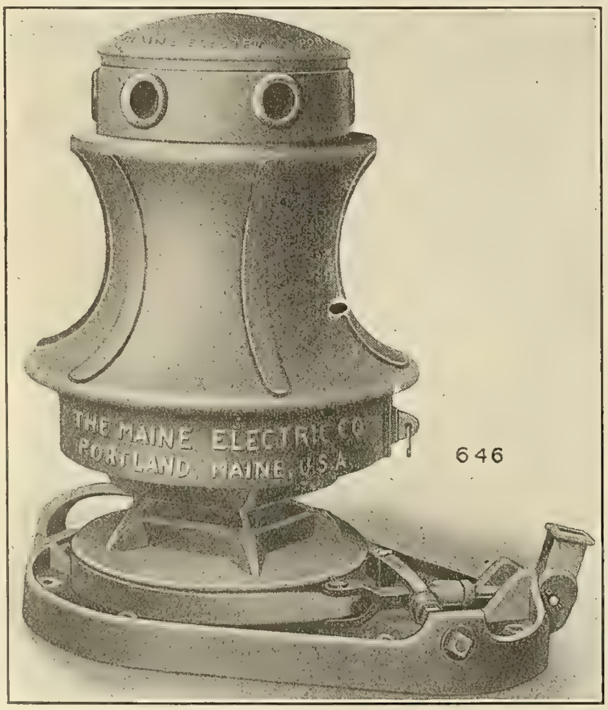

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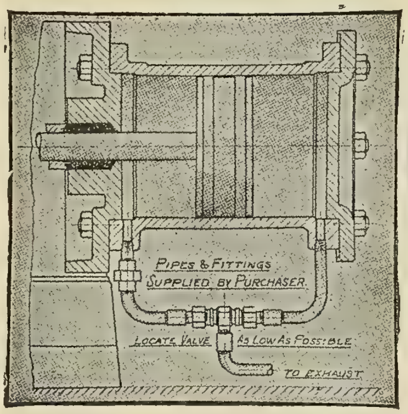

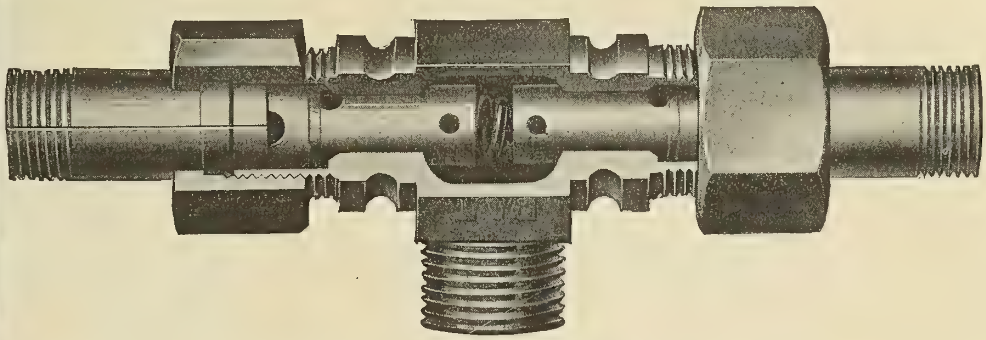

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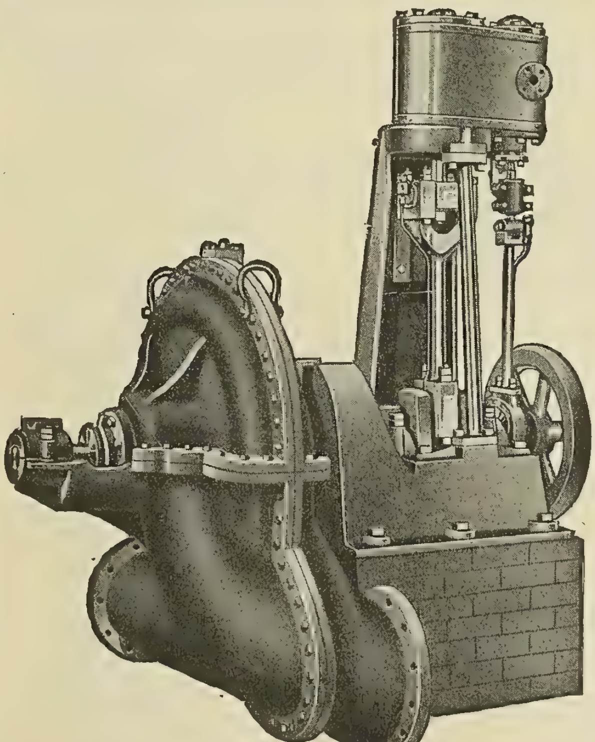

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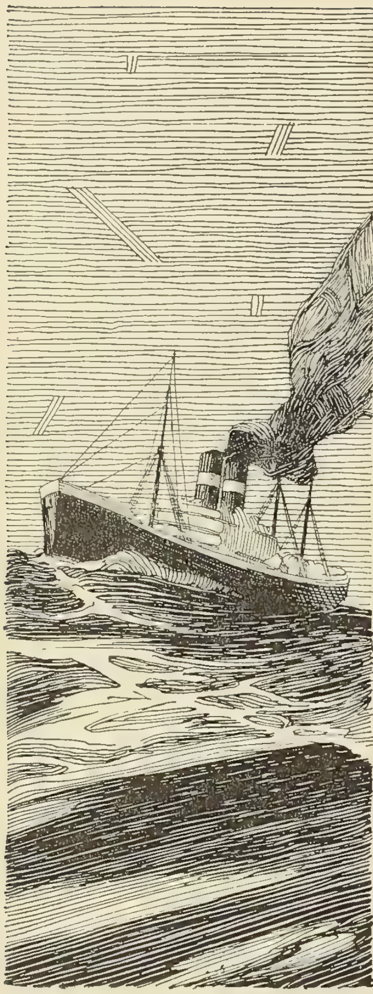

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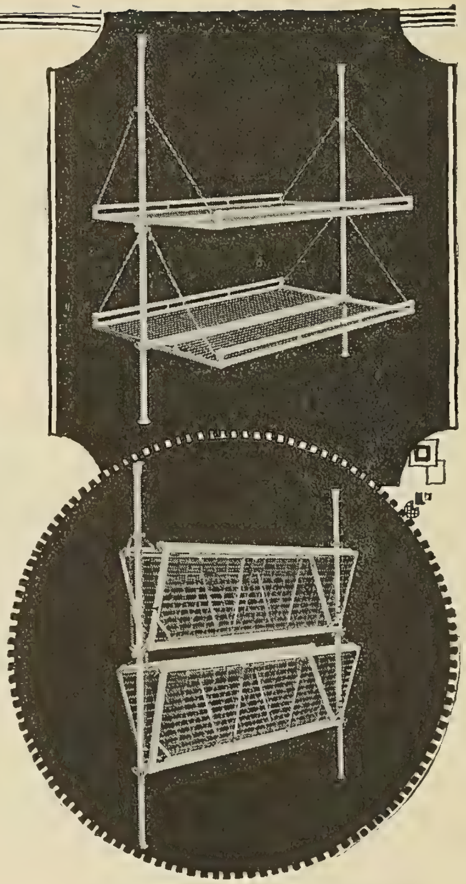

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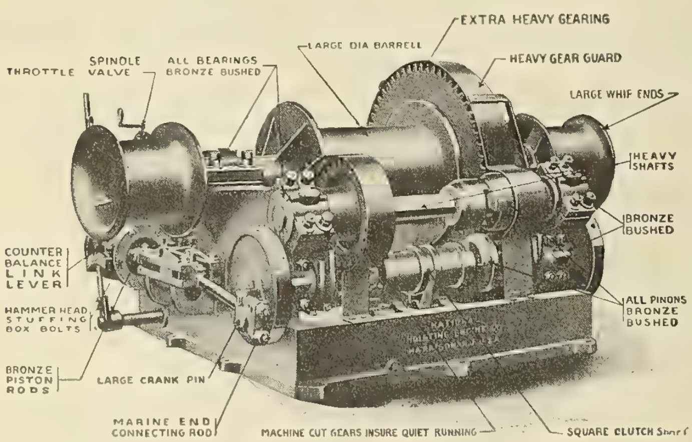

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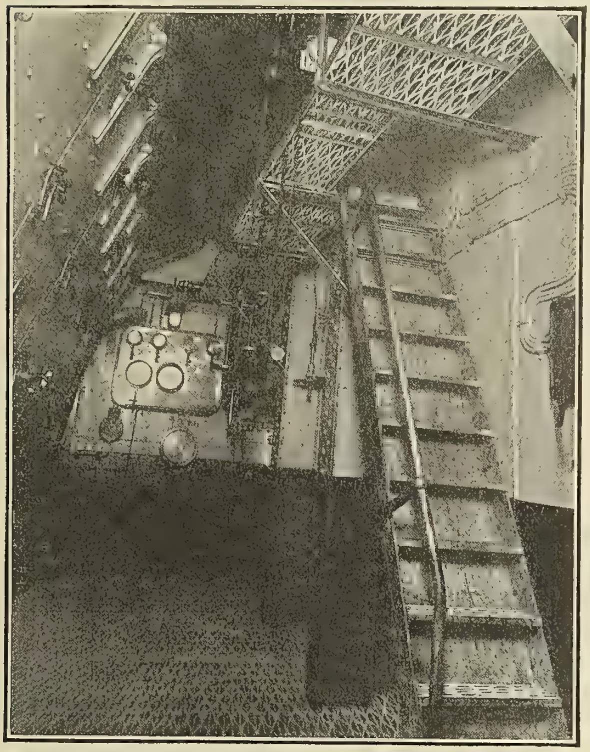

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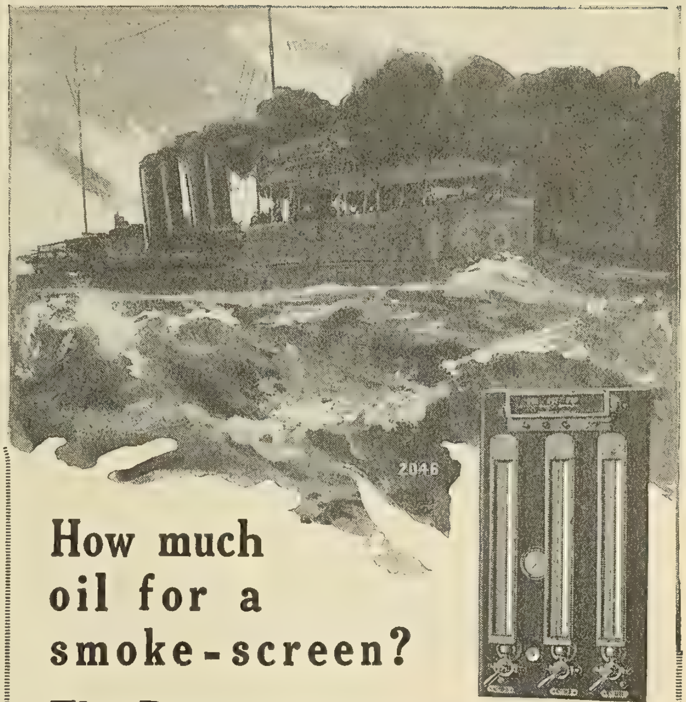

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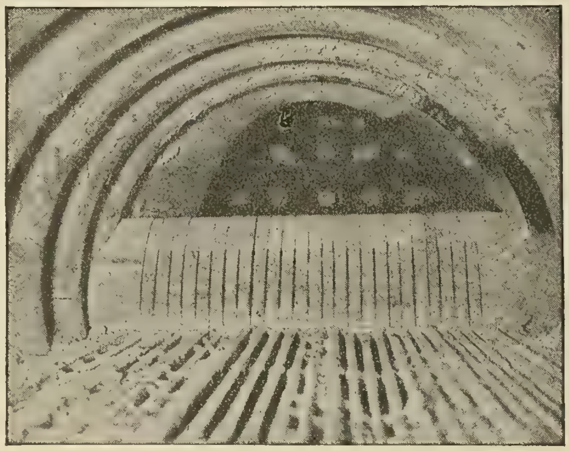

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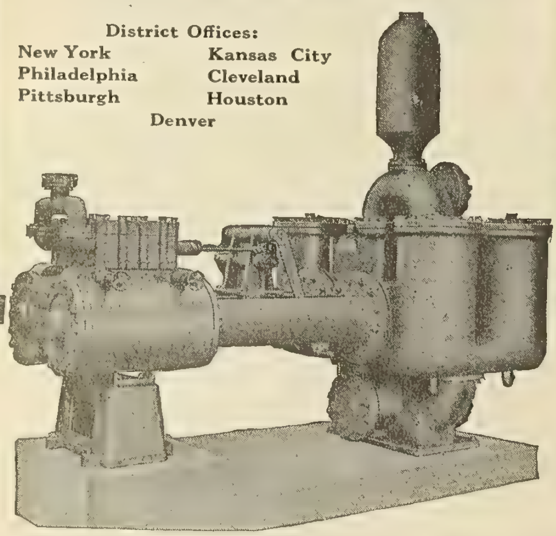

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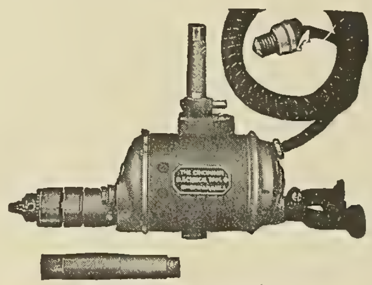

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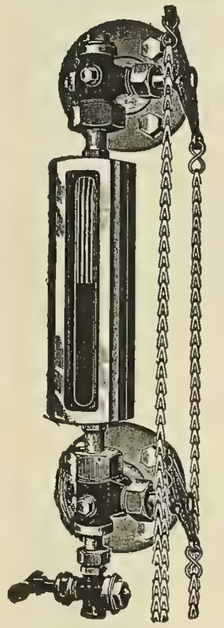

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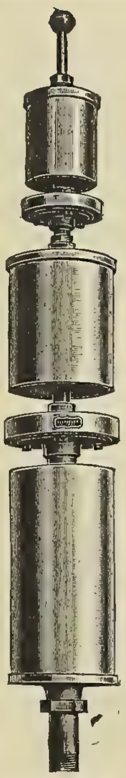

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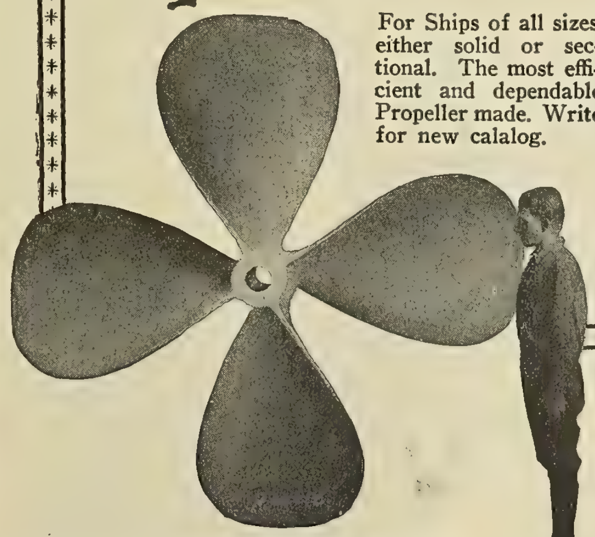

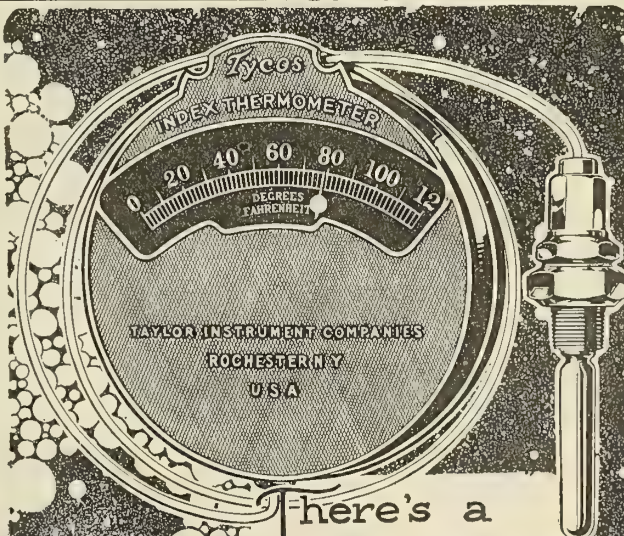
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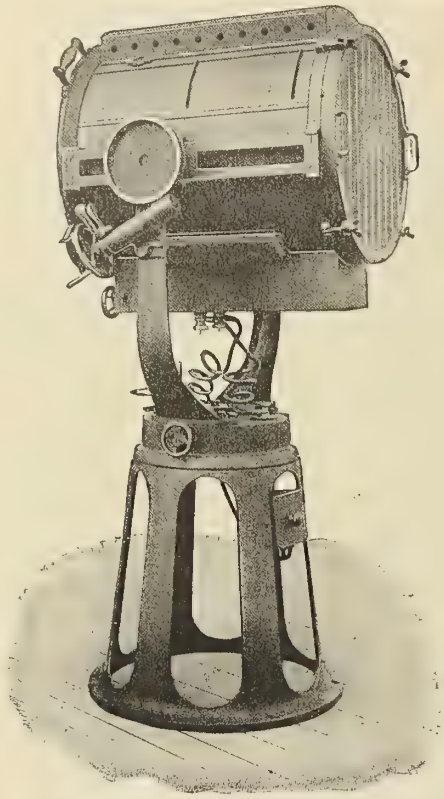

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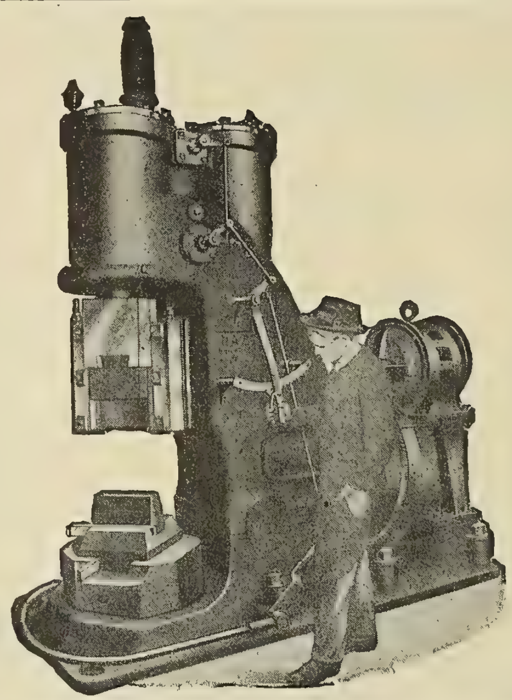

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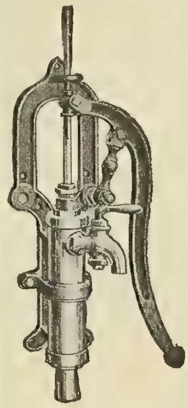

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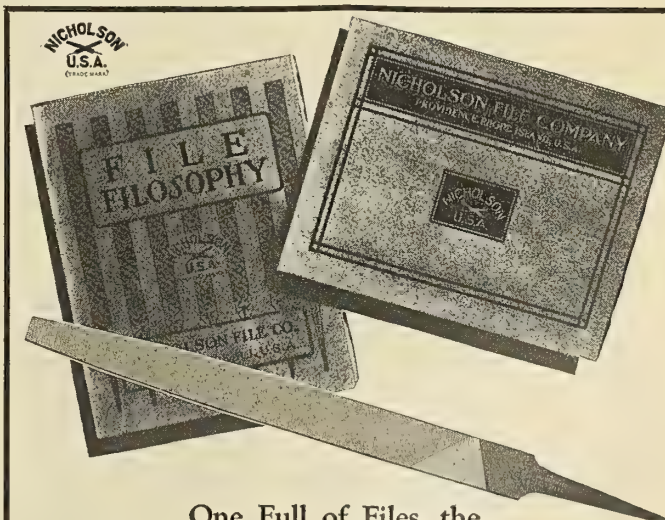

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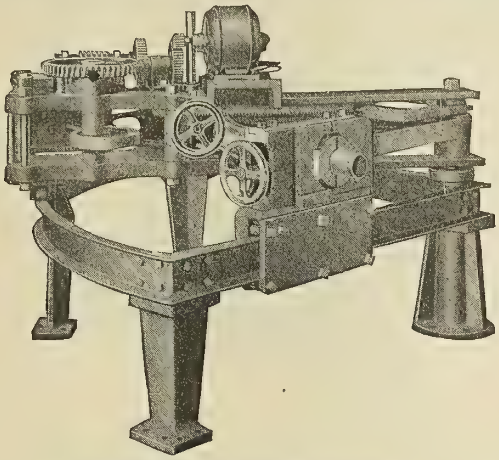

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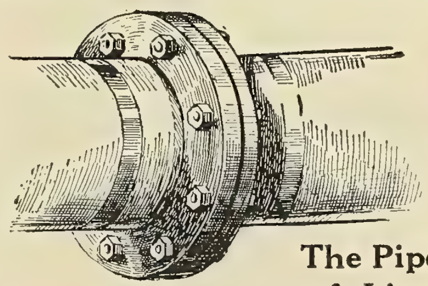

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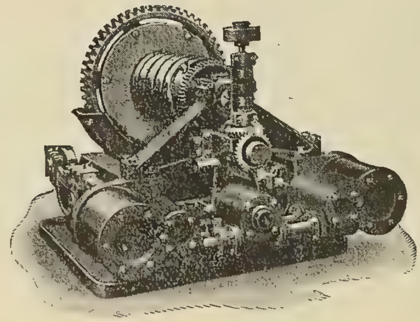

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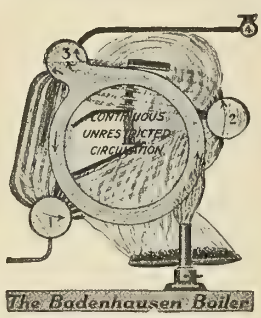

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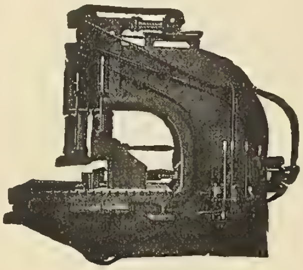

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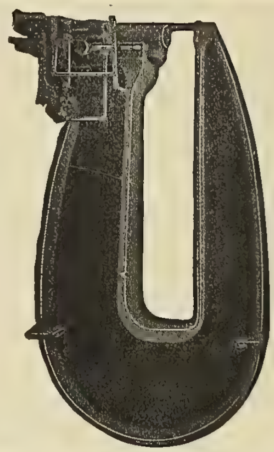

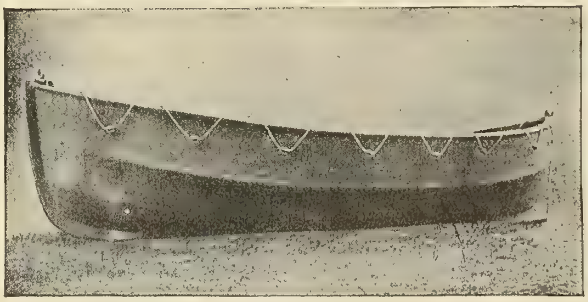

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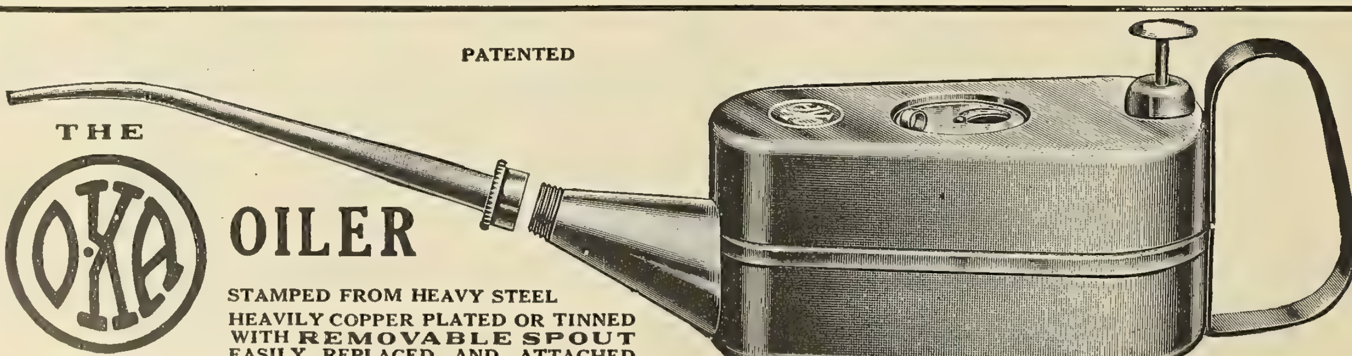

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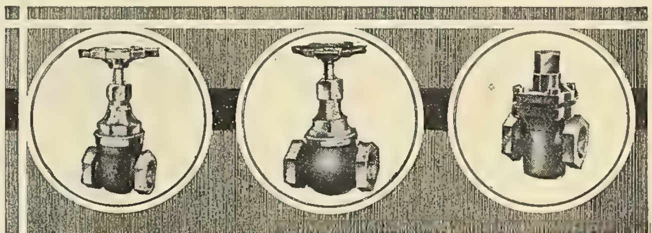

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BRASS CASTINGS
(See Castings-Brass.)

BRASS FITTINGS
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Bridgeport Brass Co.
Chase Rolling Mill Co.
Crane Company, The.
Lunkenheimer Co., The.
Mason Regulator Co.
Powell Co., The William.
Sands, A. B., & Son Co.
Tiebout, W. & J.
Waterbury Mfg. Co.
Williams Valve Mfg. Co.
Williams, Wm. E.

BRAZING MATERIALS
Smooth-On Manufacturing Co.

BRICK
(See Fire Brick.)

BRIDGE CONTROL
Westinghouse Electric & Mfg. Co.

BRIDGE WALLS
(See Furnace Bridge Walls.)

BROKERS
(See Ship Brokers.)

BRONZE
American Manganese Bronze Co.
Chase Metal Works.
Chase Rolling Mill Co.
Columbian Bronze Corp.
Cramp & Sons, Wm., Ship & Engine Bldg. Co.
Crane Co.
Lunkenheimer Co.
Powell Co., The William.
Williams Valve Co., D. T.
Williams, Wm. E.

BUNKS
Bernstein Mfg. Co.
Foster Bros. Mfg. Co.
Southern-Rome Co.

BUOYS
Williams, Wm. E.

BUOYS, RING
Ferdinand & Co., L. W.
Williams, Wm. E.

BURNERS, FUEL OIL
(See Fuel Oil Burners.)

BUSHINGS
Crane Co., The.
Lunkenheimer Co., The,
Williams, Wm. E.,

BY-PASS VALVES
Crane Co., The,
Griscom-Russell Co.
Lunkenheimer Co., The.
Powell Co., The William.
Schutte & Koerting Co.

CABLES OF ALL KINDS FOR LIGHT AND POWER
Habirshaw Electric Cable Co.
Standard Underground Cable Co.

CABLES
(See Chain; also Rope.)
National Malleable Castings Co.

CABLE COVERINGS
Tubular Woven Fabric Co.

CABLEWAYS
(See Marine Cableways.)

CALIPER GAUGES
Williams & Co., J. H.

CALKING MACHINERY
Ingersoll-Rand Co.

CALKING TOOLS
Williams, Wm. E.

CAM SHAFTS
Pollak Steel Co.

CANOE GLUE
Ferdinand & Co., L. W.

CANVAS
Williams, Wm. E.

CANVAS PRESERVATIVE AND WATERPROOFING MATERIAL
Robeson Preservo Co.

CAPSTANS
(Steam, Electric, Hand.)
American Engineering Co.
Dake Engine Co.
Flory, S., Manufacturing Co.
Hadfield-Penfield Steel Co.
Hyde Windlass Co.
Maine Electric Co.
Mundy Hoisting Engine Co.
National Hoisting Engine Co.
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

CARBON DIOXIDE, VALVES AND FITTINGS
Frick Co.
York Manufacturing Co.

CARBON DIOXIDE MACHINES
Frick Co.
York Manufacturing Co.

CAR DUMPERS
Brown Hoisting Machinery Co.
McMyler Interstate Co.

CARGO HOISTS
(See Hoisting Engines.)

CARGO HOISTING BLOCKS
Parish Supply & &Mfg. Co.

CARGO LIGHTS
Benjamin Electric Mfg. Co.
General Electric Co.
Western Electric Co.
Williams, Wm. E.

CARGO WINCHES
(See Winches.)
O'Rourke Crane & Enginer'g Co.

CAR PULLERS—ELECTRIC
Mead-Morrison Mfg. Co.

CASTINGS—ALUMINUM
Griscom-Russell Co.
Hyde Windlass Co.
Hooven, Owens, Rentschler Co.
Lunkenheimer Co., The.
Powell Co., The William.
Sands, A. B., & Son Co.
Stevens Aylsworth Co., Inc.

CASTINGS—BRASS
Benjamin Electric Mfg. Co.
Bridgeport Brass Co.
Charleston Dry Dock & Machine Co.
Cory, Chas., & Son, Inc.
Cramp, Wm. & Sons Ship & Engine Bldg. Co.
Crane Co.
Fletcher, W. & A. Co.
Griscom-Russell Co.
Hyde Windlass Co.
Lunkenheimer Co., The.
Powell Co., The William.
Rostand Manufacturing Co.
Sands, A. B., & Son Co.
Tiebout, W. & J.
Williams Valve Co., D. T.
Williams, Wm. E.

CASTING—BRONZE
American Manganese Bronze Co.
American Steel Foundries.
Benjamin Electric Mfg. Co.
Charleston Dry Dock & Machine Co.
Chase Metal Works.
Chase Rolling Mill Co.
Columbian Bronze Corp.
Cory, Charles & Son, Inc.
Cramp & Sons, Wm., Ship & Engine Bldg. Co.
Crane Co., The.
Fletcher Co., W. & A.

Lunkenheimer Co., The.
Malleable Iron Fittings Co.
Penn Seaboard Steel Corp.
Powell Co., The William.
Rostand Mfg. Co.
Sands, A. B., & Son Co.
Stevens-Aylsworth Co., Inc.
Tiebout, W. & J.
Williams Valve Co., D. T.
Williams, Wm. E.

CAPSTANS
Allan-Cunningham Co.
Maritime Engineering & Sales Corp.

CASTINGS—BRASS AND BRONZE
Bath Iron Works.

CASTINGS—GRAY IRON
Hooven, Owens, Rentschler Co.
Mesta Machine Co.
Norwalk Iron Works.
Stevens-Aylsworth Co., Inc.
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

CASTINGS—MONEL METAL
International Nickel Co.

CASTINGS—STEEL
American Steel Foundries.
Chase Metal Works.
Chase Rolling Mill Co.
Cramp & Sons, Wm., Ship & Engine Bldg. Co.
Crane Co., The.
Fletcher Co., W. & A.
Griscom-Russell Co.
Hardie-Tynes Mfg. Co.
Hooven, Owens, Rentschler Co.
Hyde Windlass Co.
Lunkenheimer Co., The.
Mesta Machine Co.
National Malleable Castings Co.
Penn Seaboard Steel Corp.
Sands, A. B., & Son Co.
Stevens-Aylsworth Co., Inc.

CEILINGS
(Cabin.)
Marine Decking & Supply Co.

CEMENT—LINOLEUM
Ferdinand & Co., L. W.

CENTRIFUGAL OIL PURIFIERS
De Laval Separator Co.

CENTRIFUGAL PUMPS
Alberger Pump & Condenser Co.
Cameron Steam Pump Wks, A. S.
Fairbanks, Morse & Co.
Morris Machine Works.
National Machine Engine Works.
Westinghouse Electric & Mfg. Co.
Wheeler Manufacturing Co.
Williams, Wm. E.
Worthington Pump & Mach. Corp.

CHAIN
Baldt Anchor Co.
Cory, Chas., & Son, Inc.
Harvey Co., Arthur C.
Kearfott Engineering Co.
National Malleable Castings Co.
Ryerson, Jos. T., & Son.
U. S. Chain & Forging Co.

CHAIN HOISTS AND BLOCKS
Chisholm-Moore Mfg. Co.
Ford Chain Block Co.
Niles-Bement-Pond Co.
Parish Supply & Mfg. Co.
Ryerson, Jos. T., & Son.
Williams, Wm. E.
Wright Mfg. Co.
Yale & Towne Mfg. Co.

CHAIN PIPE WRENCHES
American Engineering Co.
Williams, Wm. E.

CHAIN STOPPERS
American Engineering Co.
Williams, Wm. E.

CHAIN VALVE WHEELS
Lunkenheimer Co., The.
Powell Co., The William.

CHANNELS
Pollak Steel Co.

CHARCOAL IRON BOILER TUBES
Harvey Co., Arthur C.
Parkesburg Iron Co.
Ryerson, Jos. T., & Son.
Williams, Wm. E.

CHECK VALVES—BRASS AND IRON
Crane Co., The.
Lunkenheimer Co., The.
Mott Iron Works, J. L.
Powell Co., The William
Pratt & Cady Co., Inc.
Sands & Son Co., A. B.
Schutte & Koerting Co.
Watson-Stillman Co.
Williams Valve Co., D. T.
Williams, Wm. E.

CHEMICALS
(See Boiler Compounds.)

CHIPPING HAMMERS
(See Pneumatic Tools.)

CHISELS
Keller Pneumatic Tool Co.
Williams, Wm. E.

CHISEL BLANKS
Cleveland Punch & Shear Works Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.

CHRONOMETERS
Williams, Wm. E.

CHRONOMETER VALVES
Union Water Meter Co.
Williams, Wm. E.

CHOCKS
American Engineering Co.
Penn Seaboard Steel Corp.
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

CHOCK FITTINGS
Stewart Davit & Equip. Corp.

CHUCKS
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.
Rostand Mfg. Co.
Williams, Wm. E.

CIRCULAR SHEARS
The Quickwork Co.

CIRCULATING PUMPS
Alberger Pump & Condenser Co.
Cameron Steam Pump Wks, A. S.
Davidson Company, M. T.
Dean Bros. Steam Pump Works.
De Laval Steam Turbine Co.
Fairbanks, Morse & Co.
Howden, James, & Co., Ltd.
Hush, H. J.
Morris Machine Works.
Terry Steam Turbine Co.
Westinghouse Electric & Mfg. Co.
Wheeler Mfg. Co., C. H.
Williams, Wm. E.
Worthington Pump & Mach. Corp.

CIRCULATORS
(See Boiler Circulators.)

CLAMPS — MACHINISTS AND TOOL MAKERS
Williams & Co., J. H.
Williams, Wm. E.

CLASSIFICATION ASSOCIATION
American Bureau of Shipping.

CLEATS
Penn Seaboard Steel Corp.

CLINCH RINGS
Malleable Iron Fittings Co.
Williams, Wm. E.

CLOCKS
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Chelsea Clock Co.
Hand, John E., & Sons Co.
Williams, Wm. E.

COAL-HANDLING MACHINERY
Lidgerwood Manufacturing Co.
McMyler Interstate Co.
Maine Electric Co.
Mundy, J. S., Hoisting Eng. Co.
National Hoisting Engine Co.
Shepard Elec. Crane & Hoist Co.

COATINGS
(See Anti-Rust Coatings.)

COCKS
(See Gauge Cocks.)

COLD SAWS
Ryerson, Jos. T., & Son.

COMBINED AIR AND CIRCULATING PUMPS
Dean Bros. Steam Pump Works.
Wheeler Manufacturing Co.

COMPANION FLANGES
Crane Co., The.
Lunkenheimer Co., The.
Powell Co., The William.
Williams Valve Co., D. T.
Williams, Wm. E.

COMPASSES
Hand, John E., & Son Co.
Sperry Gyroscope Co.
Williams, Wm. E.

COMPOSITIONS
(See Ship's Compositions.)

COMPOUNDS
(See Boiler Compounds.)

COMPRESSION RIVETERS
(See Power Riveters.)

CONDENSERS
Alberger Pump & Condenser Co.
American Engineering Co.
Bath Iron Works.
Consolidated Shipbuilding Corp.
Davidson Co., M. T.
Dean Bros. Steam Pump Works.
Fletcher Co., W. & A.
Griscom-Russell Co.
Ingersoll-Rand Co.
Kearfott Engineering Co.
National Marine Engine Works.
Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Westinghouse Electric & Mfg. Co.
Wheeler Condenser & Eng. Co.
Wheeler Mfg. Co., C. H.
Williams, Wm. E.
Worthington Pump & Mach. Corp.

CONDENSER TUBES
Chase Metal Works.
Chase Rolling Mill Co.
Kearfott Engineering Co.
Wheeler Condenser & Eng. Co.
Williams, Wm. E.

CONDUIT BOXES
Seidler-Miner Co.

CONDUIT FITTINGS
Chicago Fuse Mfg. Co.
Crouse-Hinds Co.

CONNECTING RODS
Heppenstall Forge & Knife Co.
Pollak Steel Co.
Williams & Co., J. H.

CONSULTING ENGINEERS
(See Engineers, Consulting.)

CONVEYING MACHINERY
Lidgerwood Manufacturing Co.
McMyler Interstate Co.
Maine Electric Co.
Manning, Maxwell & Moore, Inc.
Mead-Morrison Mfg. Co.
Mundy, J. S., Hoisting Eng. Co.
National Hoisting Engine Co.
O'Rourke Crane & Eng. Co.

CONVEYORS (COAL)
(See Conveying Machinery.)

CO_2 ICE MACHINES
(See Carbon Dioxide Machines.)

COOLERS—OIL COPPERS
(See Oil Coolers.)

COPPER
(See Brass and Copper.)

COPPER PAINT FOR WOODEN VESSELS
International Compositions Co.

COPPER TUBES, RODS, WIRES
Chase Metal Works.
Chase Rolling Mill Co.
Standard Underground Cable Co.
Williams, Wm. E.

CORDAGE
(Also see Rope and Wire Rope; also Twine.)
Ajax Rope Co.
American Manufacturing Co.
Columbian Rope Co.
Durable Wire Rope Co.
Griscom-Russell Co.
Plymouth Cordage Co.
Samson Cordage Works.
Waterbury Co.
Whitlock Cordage Co.
Williams, Wm. E.

CORK CEMENT
Ferdinand, L. W., & Co.

CORRUGATED FURNACES
American Spiral Pipe Works.
Continental Iron Works, The.
Howden, James, & Co.
Ryerson, Jos. T., & Son.

COUNTERS
(See Revolution Counters.)
Cory, Chas., & Son, Inc.

COUNTERSINKS
Rich Tool Co.
Standard Tool Co.

COUPLINGS
(See Hose Couplings.)

COVERINGS — NON-CONDUCTING
(See Non-conducting Coverings.)

COWLS
Ohio Body & Blower Co.
Stevens-Aylsworth Co., Inc.

CRANES
(Also see Floating Cranes and Shipyards Whirlers.)
American Balsa Co.
American Engineering Co.
Brown Hoisting Machinery Co.
Chambersburg Engineering Co.
Chisholm-Moore Mfg. Co.
McMyler Interstate Co.
Maine Electric Co.
Manning, Maxwell & Moore, Inc.
Mead-Morrison Mfg. Co.
Niles-Bement-Pond Co.
Pawling & Harnischfeger Co.
Shepard Elec. Crane & Hoist Co.
Sprague Electric Works.
Whiting Foundry Equip. Co.

CRANK SHAFTS
Pollak Steel Co.
Williams & Co., J. H.

CREOSOTED WOOD BLOCKS, LUMBER, TIMBERS, PILING, DECKING
Long-Bell Lumber Co.

CUT NAILS
Malleable Iron Fittings Co.
Reading Iron Co.

CUTTERS
Pratt & Whitney Co.
Standard Tool Co.
Waycott, A. W.
Williams, Wm. E.

CUTTING COMPOUNDS
Texas Co., The.
Williams, Wm. E.

CUTTING & WELDING
(See Welding.)

CYLINDER BORING BARS
Niles-Bement-Pond Co.
Williams & Co., J. H.

CYLINDER RELIEF VALVES
(See Valves.)

CYLINDERS FOR COMPRESSED AIR, GAS, ETC.
Continental Iron Works, The.
National Tube Co.

DAVITS
American Balsa Co.
Morse Dry Dock & Repair Co.
Steward Davit & Equip. Corp.

DECK FITTINGS
Penn Seaboard Steel Corp.
Stevens-Aylsworth Co., Inc.
Steward Davit & Equip. Corp.
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

DECK PLATES
Harvey Co., Arthur C.
Sands & Son, A. B.
Williams, Wm. E.

DECK PUMPS
Dean Bros. Steam Pump Works.
Sands & Son Co., A. B.
Williams, Wm. E.

DECKING
Marine Decking & Supply Co.

DEPTH RECORDERS
Hand, J. E., & Sons Co.

DERRICKS
Lidgerwood Manufacturing Co.
McMyler Insterstate Co.
Maine Electric Co.

DERRICK CARS
McMyler Interstate Co.
Maine Electric Co.

DERRICK IRONS
Lidgerwood Manufacturing Co.

DETACHING GEAR (BOAT)
American Balsa Co.
Morse Dry Dock & Repair Co.
Steward Davit & Equip. Corp.

DIAPHRAGM PUMPS
Hyde Windlass Co.

DIE BLOCKS
Heppenstall Forge & Knife Co.
Pollak Steel Co.
Ryerson, Jos. T., & Son.

DIES
Brubaker & Bros., W. L.
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son.
Williams, Wm. E.

DIESEL ENGINES
(Also see Engines, Oil,)
Cramp, Wm., & Sons Ship & Engine Bldg. Co.
Hadfield-Penfield Steel Co.
Johannsen, H. S.
Kearfott Engineering Co.
McIntosh & Seymour Corp.
New London Ship & Engine Co.
Western Machinery Co.
Winton Engine Works.
Worthington Pump & Mach. Corp.

DIRECT-CONNECTED SETS
(See Electrical Plants.)

DIRECTION AND REVOLUTION INDICATORS
Cory, Chas., & Son, Inc.

DISENGAGING GEARS
American Balsa Co.
Steward Davit & Equip. Corp.

DISTILLERS
(See Evaporators.)

DIVING APPARATUS
Morse, Andrew J., & Son, Inc.

DOCK FITTINGS
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

DRAFT GAUGES
Pneumercator Co.
Williams, Wm. E.

DRAFTING INSTRUMENTS
New York Blue Print Paper Co.
Starrett, L. S., Co.

DRAIN VALVES
(See Valves.)

DRAWING MATERIALS
(Board, Cloth, Paper, Ink, Etc.)
National Tracing Cloth Co.
New York Blue Print Paper Co.
Starrett Co., L. S.

DRAWING PENCILS
American Lead Pencil Co.
Dixon Crucible Co.

DRAFTING ROOM FURNITURE
New York Blue Print Paper Co.

DREDGES
Morris Machine Works.

DREDGING MACHINERY
Alberger Pump & Condenser Co.
American Engineering Co.
Fletcher Co., W. & A.
Flory Manufacturing Co.
Lidgerwood Manufacturing Co.
McMyler Interstate Co.
Morris Machine Works.
Mundy Hoisting Engine Co., J. S.
National Marine Engine Works.

DREDGING PUMPS
Morris Machine Works.
National Marine Engine Works.
Terry Steam Turbine Co.
Worthington Pump & Mach. Corp.

DRIFT PINS
Cleveland Punch & Shear Works Co.
Williams, Wm. E.

DRILLING MACHINES
Lynd-Farquhar Co.
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.

DRILLS
Pratt & Whitney Co.
Rich Tool Co.
Standard Tool Co.
Williams, Wm. E.

DRILLS, ELECTRIC
(See Electric Drills.)

DRILLS, PNEUMATIC
(See Pneumatic Tools.)

DRILLS, PORTABLE
(See Portable Drills.)

DRILLS, WALL RADIAL
(See Radial Drills.)

DROP FORGINGS
(Eye Bolts, Wrenches, Etc.)
Mesta Machine Co.
Pollak Steel Co.
U. S. Chain & Forging Co.
Williams & Co., J. H.
Williams, Wm. E.

DROP HAMMERS
Chambersburg Engineering Co.
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.

DRY DOCK PUMPS
Cameron Steam Pump Wks., A. S.
Morris Machine Works.
Worthington Pump & Mach. Corp.

DRY DOCKS
(Manufacturer and Marine Railways.)
Crandall Engineering Co.

DRY DOCKS AND MARINE RAILWAYS
Baltimore Dry Docks & Shipbuilding Co.
Bethlehem Shipbuild'g Corp. Ltd.
Charleston Dry Dock & Machine Co.
Cramp, Wm., & Sons Ship & Engine Bldg. Co.
Merchant Shipbuilding Corp.
Morse Dry Dock & Repair Co.
Newport News Shipbuilding & Dry Dock Co.
Staten Island Shipbuilding Co.
Todd Shipyards Corp.
Union Dry Dock & Repair Co.

DYNAMOS
See Electric Plants.)

ECCENTRIC RODS
Pollak Steel Co.

ECONOMIZERS, FUEL
(See Fuel Economizer.)

EJECTORS
Lunkenheimer Co.
Schutte & Koerting Co.
Williams, Wm. E.

ELECTRIC CRANES
(See Electric Hoists.)

ELECTRIC CUTOUTS
Chicago Fuse Mfg. Co.
Conlan Electric Corp.
Crouse-Hinds Co.
Seidler-Miner Co., Inc.

ELECTRIC DRILLS AND GRINDERS
Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
General Electric Co.
Independent Pneumatic Tool Co.
United States Electrical Tool Co.
Williams, Wm. E.

ELECTRIC DRIVEN PUMPS
Cameron Steam Pump Wks, A. S.
Dean Bros. Steam Pump Works.
Fairbanks, Morse & Co.
Kinney Manufacturing Co.

ELECTRIC FREIGHT TRUCKS
(See Freight-Handling.)

ELECTRIC HEATERS
American Car & Foundry Co.
Cory, Chas., & Son, Inc.
General Electric Co.

ELECTRIC HOISTS
Allan-Cunningham Co.
American Engineering Co.
Brown Hoisting Machinery Co.
Chicago Pneumatic Tool Co.
Dake Engine Co.
General Electric Co.
Hyde Windlass Co.
Lidgerwood Manufacturing Co.
Maine Electric Co.
Maritime Engineering & Sales Corp.
Mead-Morrison Mfg. Co.
Mundy Hoisting Eng. Co., J. S.
National Hoisting Engine Co.
Niles-Bement-Pond Co.
Shepard Elec. Crane & Hoist Co.
Western Electric Co.

ELECTRIC LIGHTING
Benjamin Electric Mfg. Co.
Conlan Electric Corp.
Cory, Chas., & Son, Inc.
Crouse-Hinds Co.
General Electric Co.
Morse Dry Dock & Repair Co.
Seidler-Miner Co., Inc.
Western Electric Co.

ELECTRIC METERS
(See Meters, Electric.)

ELECTRIC PLANTS
Benjamin Electric Mfg. Co.
Conlan Electric Co.
Consolidated Shipbuilding Corp.
Cory, Chas., & Son, Inc.
Fairbanks, Morse & Co.
General Electric Co.
Mietz Corporation.
Seidler-Miner Co., Inc.
Terry Steam Turbine Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

ELECTRIC PUMPS
(See Electric Driven Pumps.)

ELECTRIC SIGNALS
Cory, Chas., & Son, Inc.
Seidler-Miner Co., Inc.

ELECTRIC TACHOMETERS
Cory, Chas., & Son, Inc.
Seidler-Miner Co., Inc.

ELECTRIC WELDING
(See Welding, Electric.)

ELECTRICAL APPLIANCES, INSTALLATIONS, FITTINGS AND SUPPLIES
Benjamin Electric Mfg. Co.
Chicago Fuse Mfg. Co.
Cory, Chas., & Son, Inc.
Crouse-Hinds Co.
General Electric Co.
Seidler-Miner Co., Inc.
Western Electric Co.
Williams, Wm. E.

ELECTRICAL INSTRUMENTS
Conlan Electric Co.
Cory, Chas., & Son, Inc.
General Electric Co.
Seidler-Miner Co., Inc.
Western Electric Co.
Weston Electrical Instrument Co.
Williams, Wm. E.

ELECTRIC WIRE COVERINGS
Tubular Woven Fabric Co.

ELECTRICAL WIRING DEVICES
(Switches, Sockets, Etc.)
Benjamin Electric Mfg. Co.
Conlan Electric Co.
Cory, Chas., & Son, Inc.
Seidler-Miner Co., Inc.
Western Electric Co.
Williams, Wm. E.

ELEVATORS, AIR AND HYDRAULIC
(Also see Portable Eelevators.)
Whiting Foundry Equipment Co.

ENGINE LOGS
Cory, Chas., & Son, Inc.
Williams, Wm. E.

ENGINE OIL
(See Lubricants.)

ENGINE PACKING
(See Packing.)

ENGINE ROOM COUNTERS
(See Revolution Counters.)

ENGINE ROOM TELEGRAPHS
Cory, Chas., & Son, Inc.

ENGINEERS, CONSULTING—MARINE
American Engineering Co.
American Ship Building Co.
Benjamin Electric Mfg. Co.
Bogert, J. L.
Bonner, William T.
Chapman & Fisher.
Cox & Stevens.
Crandall Engineering Co.
Donnelly, W. T.
Ferris, Theodore.
Haight, Robert S.
Max Hansen.
Harris, Leonard B.
Hough, Edward S.
Howden & Co., Ltd.
Leslie Stevens Co.
Lysholm, Henry, Inc.
Matthews, John B.
McClelland & Co., N. E., Ltd.
McKinlay, James.
McNab Co., The.
Morse Drn Dock & Repair Co.
Nilson, Leonard J.
Reid & Co., John.
Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Union Dry Dock & Repair Co.
Watts, J. Murray.

ENGINEERS, ELECTRICAL
Cory, Chas., & Son, Inc.

ENGINES FOR AUXILIARIES
Alberger Pump & Condenser Co.
Bolinders Co.
Consolidated Shipbuilding Corp.
De Laval Steam Turbine Co.
Fairbanks, Morse & Co.
Howden & Co.
Hyde Windlass Co.
Johannsen, H. S.
Kearfott Engineering Co.
McIntosh & Seymour Corp.
Maine Electric Co.
Mietz Corporation, August.
Morris Machine Works.
New London Ship & Engine Co.
Reid & Co., John.
Skandia Oil Engines.
Terry Steam Turbine Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Mach. Corp.

ENGINES, GASOLINE
(See Gasoline Engines.)

ENGINES, HOISTING
(See Hoisting Engines.)

ENGINES, KEROSENE
(See Kerosene Engines.)

ENGINES, OIL
(Also see Diesel Engines.)
Bolinders Co.
Chicago Pneumatic Tool Co.
Consolidated Shipbuilding Corp.
Fairbanks, Morse & Co.
Hadfield-Penfield Steel Co.
Ingersoll-Rand Co.
Johannsen, H. S.
Kearfott Engineering Co.
McIntosh & Seymour Corp.
Mietz Corporation, August.
Morse Dry Dock & Repair Co.
New London Ship & Engine Co.
Skandia Oil Engines.
Standard Motor Construction Co.
Western Machinery Co.
Winton Engine Co.
Worthington Pump & Mach. Corp.

ENGINES, PROPELLING
American Ship Building Co.
Ames Shipbuilding & Dry Dock Co.
Badenhausen Co.
Bath Iron Works.
Bethlehem Shipbuilding Corp.
Bolinders Co.
Consolidated Shipbuilding Corp.
Cramp & Sons, Wm., Ship & Engine Bldg. Co.
Fairbanks, Morse & Co.
Fletcher Co., W. & A.
Hadfield-Penfield Steel Co.
Hardie-Tynes Mfg. Co.
Hooven, Owens, Rentschler Co.
Howden & Co., James.
Ingersoll-Rand Co.
Johannsen, H. S.
Kearfott Engineering Co.
Los Angeles Shipbuilding & Dry Dock Co.
McIntosh & Seymour Corp.
Mietz Corporation, August.
Morris Machine Works.
Morse Dry Dock & Repair Co.
National Marine Engine Works.
New London Ship & Engine Co.
Parsons Marine Steam Turbine Co.
Reid & Co., John.
Skandia Oil Engine.
Standard Motor Construction Co.
Staten Island Shipbuilding Co.
Trout Co., H. G.
Vulcan Irin Works, Inc.
Ward, Chas., Engineering Works.
Winton Engine Co.
Worthington Pump & Machinery Corp.

ENGINES, PUMPING
Alberger Pump & Condenser Co.
Davidson Co., M. T.
Fairbanks, Morse & Co.
Griscom-Russell Co.
Hush, H. J.
Kearfott Engineering Co.
Morris Machine Works.
Row & Davis, Engineers, Inc.
Terry Steam Turbine Co.
Worthington Pump & Mach. Corp.

ENGINE-ROOM CLOCKS
(See Clocks.)

ENGINE ROOM GRATINGS
Irving Iron Works Co.

ENGINE-ROOM SUPPLIES
(See Steam Specialties.)

ENGINE ROOM TELEGRAPHS
Chadburn (Ship) Telegraph Co.
McNab Co., The.
Williams, Wm. E.

ERASERS
Dixon Crucible Co., Joseph.
New York Blue Print Paper Co.

EVAPORATORS
Alberger Pump & Condenser Co.
American Engineering Co.
Davidson Co., M. T.
Griscom-Russell Co.
Kerfott Engineering Co.
Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Williams, Wm. E.

EXHAUST FANS
(See Blowers.)

EXPANDERS
(See Boiler Flue Expanders and Pipe Expanding and Flanging Machines.)

EXPANSION JOINTS
Alberger Pump & Condenser Co.
Crane Co., The.
Griscom-Russell Co.
Lunkenheimer Co.
Powell Co., The William.
Ross Heater & Mfg. Co.

EYE BOLTS
Williams & Co., J. H.
Williams, Wm. E.

FAIRLEADERS
Thacher Propeller & Foundry Corp.

FANS
(See Blowers.)

FEED WATER HEATERS
Chaplin-Fulton Mfg. Co.
Griscom-Russell Co.
Kearfott Engineering Co.
Pratt & Cady Co., Inc.
Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Williams, Wm. E.
Worthington Pump & Machinery Corp.

FEED WATER REGULATORS
Alberger Pump & Condenser Co.
Chaplin-Fulton Mfg. Co.
Jerguson Gage & Valve Co.
Kearfott Engineering Co.
Pratt & Cady Co., Inc.

FENCES
(See Wire Fences.)

FERRULES—CONDENSER TUBE
(See Condenser Tube Ferrules.)

FILES
Nicholson File Co.
Williams, Wm. E.

FILLING STATION EQUIPMENT
Wayne Oil Tank & Pump Co.

FILTERS—MARINE OIL
Griscom-Russell Co.
Kearfott Engineering Co.
Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Williams, Wm. E.

FIRE ALARM SYSTEMS
Cory, Charles & Son, Inc.
Fire Detecting Wire Co.
Kidde Co., Inc., Walter.

FIRE DEPARTMENT SUPPLIES
Foamite Firefoam Co.
Morse, Andrew J., & Son, Inc.

FIRE DEPARTMENT SUPPLIES
Kidde Co., Inc., Walter.

FIRE EXTINGUISHERS
Kidde Co., Inc., Walter.
Morse, Andrew J., & Son, Inc.
Schutte & Koerting Co.
Williams, Wm. E.

FIRE HOSE
(See Hose.)

FIREPROOF LUMBER
(See Lumber, Fireproof.)

FIRE PUMPS
Dean Bros. Steam Pump Works.
Morris Machine Works.
Worthington Pump & Mach. Corp.

FLAGS & PENNANTS
Granger, George B., Co.
Williams, Wm. E.

FLANGED BOILER HEADS
Lukens Steel Co.
Ryerson, Jos. T., & Son.

FLANGES
American Spiral Pipe Works.
Crane Co., The.
Dart, E. M., Mfg. Co.
Lunkenheimer Co., The.
Penn Seaboard Steel Corp.
Ryerson, Jos. T., & Son.
Williams Valve Co., D. T.
Williams, Wm. E.

FLANGING MACHINES
Chambersburg Engineering Co.
McCabe Manufacturing Co.
Niles-Bement-Pond Co.
Watson-Stillman Co.

FLEXIBLE CORDS AND CABLES
Tubular Woven Fabric Co.

FLOATING CRANES
(Also see Cranes.)
McMyler-Interstate Co.
Maine Electric Co.

FLOAT VALVES
Crane Co., The.
Lunkenheimer Co., The.
Mason Regulator Co.

FLOATING DRY DOCKS
(See Dry Docks.)

FLOATING DRY DOCK CABLES
Habirshaw Electric Cable Co.

FLOOR GRATINGS
Irving Iron Works Co.

FLOOR PLATES
Crane Co., The.
Harvey, Arthur C., Co.
Ryerson, Jos. T., & Son.

FLUE CLEANERS
(See Boiler Flue Cleaners.)

FLUE CUTTERS
(See Boiler Flue Cutters.)

FLUE HOLE PUNCHES AND DIES
Cleveland Punch & Shear Works Co.

FLUE RATTLERS
Baird Pneumatic Tool Co.

FOG HORNS
Cory, Chas., & Son, Inc.
Hand, John E., & Sons Co.
Williams, Wm. E.

FOLDING ANCHORS
Malleable Iron Fittings Co.

FORCED DRAFT
(See also Blowers.)
De Laval Steam Turbine Co.
General Electric Co.
Howden, James, & Co.
Kearfott Engineering Co.
Reid & Co., John,
Terry Steam Turbine Co.

FORGES
Baird Pneumatic Tool Co.
Baush Machine Tool Co.
Buffalo Forge Co.

FORGINGS, BRONZE
Camden Forge Co.
Hyde Windlass Co.
Pollak Steel Co.
Stevens-Aylsworth Co., Inc.

FORGINGS—DROP
(See Drop Forgings.)

FORGINGS, IRON AND STEEL
(Also see Drop Forgings.)
Baldt Anchor Co.
Camden Forge Co.
Charleston Dry Dock & Machine Co.
Heppenstall Forge & Knife Co.
Mesta Machine Co.
Morse Dry Dock & Repair Co.
Pollak Steel Co.
Stevens-Aylsworth Co., Inc.
Thacher Propeller & Foundry Corp.

FORGINGS—MONEL METAL
International Nickel Co.

FOUNDRY EQUIPMENT
Whiting Foundry Equipment Co.

FREIGHT-HANDLING EQUIPMENT
Brown Hoisting Machinery Co.
Chisholm-Moore Mfg. Co.
General Electric Co.
Lidgerwood Manufacturing Co.
McMyler Interstate Co.
Maine Electric Co.
Manning, Maxwell & Moore, Inc.
Mead-Morrison Mfg. Co.
Mundy, J. S., Hoisting Engine Co.
National Hoisting Engine Co.
Sheppard Elec. Crane & Hoist Co.
Sprague Electric Works.
Towmotor Co., The.
Western Electric Co.

FREIGHT TRUCKS
Packard Motor Car Co.
Towmotor Co., The.

FRICTION SAWS
Ryerson, Jos. T., & Son.

FROST PROOF COVERINGS
Ferdinand, L. W., & Co.

FUEL ECONOMIZERS
Griscom-Russell Co.
Magnesia Association of America.

FUEL OIL
Sun Co.
Texas Co., The.

FUEL OIL ATOMIZERS
Schutte & Koerting Co.

FUEL OIL BURNERS
Baush Machine Tool Co.
Schuette & Koerting Co.
White Fuel Oil Engineering Corp.
Williams, Wm. E.

FUEL OIL HEATERS
Griscom-Russell Co.
Ross Heater & Mfg. Co.
Williams, Wm. E.

FURNACE BRIDGE WALLS
Wager Furnace Bridge Wall Co., Inc.

FURNACE CEMENT
Waycott, A. K.

FURNACE FRONTS
Continental Iron Works, The.
Fletcher Co., W. & A.
Howden & Co., James.
Reid & Co., John.

FURNACES
(Also see Oil Furnaces.)
American Car & Foundry Co.
American Spiral Pipe Works.
Baird Pneumatic Tool Co.
Continental Iron Works, The.
Wayne Oil Tank & Pump Co.

FUSES
Chicago Fuse Mfg. Co.
Crouse-Hinds Co.

FUSIBLE PLUGS
Crane Co., The.
Griscom-Russell Co.
Lunkenheimer Co., The.
Williams Valve Co., D. T.
Williams, Wm. E.

GALLEY PUMPS
Mott Iron Works, J. L.
Sands & Son, Co., A. B.
Williams, Wm. E.

GALLEYS
(See Ranges.)

GALVANIZED MATERIAL
Sands, A. B., & Son Co.
Tiebout, W. & J.
Williams, Wm. E.

GANTRY CRANES
Niles-Bement-Pond Co.

GAS COMPRESSORS
Norwalk Iron Works.

GAS ENGINE SPECIALTIES
Crane Co., The.
Lunkenheimer Co., The.
Powell Co., The William..
Pratt & Cady Co., Inc.
Schutte & Koerting Co.
Williams Valve Co., D. T.

GASKETS
(Also see Packing.)
Crane Co., The.
Goetze Gasket & Packing Co.
Goodrich Rubber Co., B. F.
Griscom-Russell Co.
New York Belting & Packing Co.
Smooth-On Manufacturing Co.
United States Rubber Co.
Williams, Wm. E.

GASOLINE
Texas Co., The.

GASOLINE ENGINES
Consolidated Shipbuilding Corp.
Fairbanks, Morse & Co.
Hush, H. J.
Standard Motor Construction Co.
Winton Engine Co.

GASOLINE PUMPS
Sands & Son Co., A. B.
Worthington Pump & Machinery Corp.

GATE VALVES — BRASS AND IRON
Crane Co., The.
Lunkenheimer Co., The.
Powell Co., The William.
Pratt & Cady, Inc.
Schutte & Koerting Co.
Williams Valve Co., D. T.
Williams, Wm. E.

GATE VALVES FOR TANK STEAMERS
Pratt & Cady Co., Inc.
Williams, Wm. E.

GAUGE COCKS
American Steam Gauge & Valve Mfg. Co.
Jerguson Gage & Valve Co.
Lunkenheimer Co., The.
Powell Co., The William.
Pratt & Cady Co., Inc.
Sands & Son Co., A. B.
Williams Valve Co., D. T.
Williams, Wm. E.

GAUGE GLASSES
Crane Co., The.
Jerguson Gage & Valve Co.
Lunkenheimer Co., The.
Powell Co., The William.
Williams Valve Co., D. T.
Williams, Wm. E.

GAUGES
(See Draft Gauges; also Tank Gauges.)

GAUGES—MANUFACTURERS'
(Also see Steam Gauges.)
Manning, Maxwell & Moore, Inc.
Pratt & Whitney Co.
Starrett Co., L. S.

GAUGE TESTERS
American Steam Gauge & Valve Mfg. Co.

GEARS
De Laval Steam Turbine Co.
Falk Co., The.
Penn Seaboard Steel Corp.
Westinghouse Electric & Mfg. Co.

GENERAL WELDING AND CUTTING EQUIPMENT
(See Welding & Cutting Apparatus and Supplies.)

GENERATING SETS
Fairbanks, Morse & Co.
General Electric Co.
Mietz Corporation.
Terry Steam Turbine Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.
Williams, Wm. E.

GENERATORS
Benjamin Electric Mfg. Co.
Crouse-Hinds Co.
Fairbanks, Morse & Co.
General Electric Co.
Western Electric Co.
Williams, Wm. E.

GLOBE VALVES—BRASS AND IRON
Crane Co., The.
Lunkenheimer Co., The.
Powell Co., The William.
Pratt & Cady Co., Inc.
Schutte & Koerting, Inc.
Williams Valve Co., D. T.
Williams, Wm. E.

GLUE—MARINE
American Glue Co.
Ferdinand & Co., L. W.
Williams, Wm. E.

GOVERNOR VALVES
Crane Co., The.
Lunkenheimer Co., The.
Schutte & Koerting Co.
Union Water Meter Co.
Williams, Wm. E.

GOVERNORS
Cory, Chas., & Son, Inc.

GRAB BUCKETS
Mead-Morrison Mfg. Co.

GRAPHITE
Dixon Crucible Co., Jos.

GRATINGS—FOR ENGINE ROOM FLOORS, ETC.
Irving Iron Works Co.

GREASE
(See Lubricants.)

GREASE CUPS
Crane Co., The.
Lunkenheimer Co., The.
Powell Co., The William.
Sun Co.
Waterbury Mfg. Co.
Williams Valve Co., D. T.

GREASE EXTRACTORS
American Steam Gauge & Valve Mfg. Co.
Griscom-Russell Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.
Williams, Wm. E.

GRINDERS—ELECTRIC AND PNEUMATIC
Chicago Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Keller Pneumatic Tool Co.
United States Electrical Tool Co.
Western Electric Co.

GRINDING MACHINES
(Plain and Universal.)
Ryerson, Jos. T., & Son.

GUILLOTINE SHEARS
Cleveland Punch & Shear Works Co.
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.

GUY ANCHORS
Crouse-Hinds Co.

GYPSEYS
American Engineering Co.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Maine Electric Co.
Mundy Hoisting Engine Co., J. S.

GYRO-COMPASSES
Sperry Gyroscope Co.

GYRO-STABILIZER
Sperry Gyroscope Co.

HACK SAWS
Goodell-Pratt Co.
L. S. Starrett Co.

HAMMERS
Bradley & Son, C. C.
Nazel Engineering & Mach. Co.

HAMMERS, PNEUMATIC
(See Pneumatic Tools.)

HAMMERS, STEAM
Chambersburg Eng. Works.
Nazel Engineering & Mach. Co.
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.

HAMMOCKS
(See Couch Hammocks.)

HANDLES (CRANK, BALANCE, MACHINE)
Williams & Co., J. H.

HARDWARE
(See Marine Hardware.)

HARDWOOD
(See Lumber.)

HAWSER REELS
Thacher Propeller & Foundry Corp.
Williams, Wm. E.

HAWSERS—MANILA
(Also see Rope and Wire Rope.)
American Mfg. Co.
Columbian Rope Co.
Plymouth Cordage Co.
Waterbury Co., The.
Whitlock Cordage Co.
Williams, William E.

HEAT INSULATION
(Also see Non-Conducting Coverings.)
American Balsa Co.
Magnesia Association of America.

HEATERS
(Bath, Lavotory, Shower.)
Alberger Pump & Condenser Co.
Griscom-Russell Co.
Kearfott Engineering Co.
Mott Iron Works, J. L.
Pratt & Cady Co., Inc.
Ross Heater & Mfg. Co.
Sands & Son Co., A. B.
Schutte & Koerting Co.
Williams, Wm. E.

HEMP
(See Twine.)

HOIST HOOKS
Williams, J. H., & Co.
Williams, Wm. E.

HOISTING ENGINES
Allan-Cunningham Co.
American Engineering Co.
Dake Engine Co.
Fairbanks, Morse & Co.
Flory Manufacturing Co., S.
Hadfield-Penfield Steel Co.
Hush, H. J.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Maine Electric Co.
Maritime Engineering & Sales Corp.
Mead-Morrison Mfg. Co.
Mundy Hoisting Engine Co., J. S.
National Hoisting Engine Co.

HOISTING AND TRANSMISSION ROPE
(See Rope.)

HOISTS, CHAIN
(See Chain Hoists.)

HOISTS, ELECTRIC
(See Electric Hoists.)

HOLDERS-ON
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.

HOLLOW BORING
Pollak Steel Co.

HORIZONTAL PUNCHES
Cleveland Punch & Shear Works Co.

HOSE
(Also see Air Hose.)
Chicago Pneumatic Tool Co.
Goodrich Rubber Co., B. F.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.
New York Belting & Packing Co.
Oldham & Son Co., George.

HOSE COUPLING
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.
Oldham & Son Co., George.

HOSE NOZZLES
Morse, Andrew J., Sons, Inc.

HUMIDIFIERS
Griscom-Russell Co.
Schutte & Koerting Co.

HYDRAULIC FITTINGS
Crane Co., The.
Lunkenheimer Co.
Penn Seaboard Steel Corp.
Powell Co., The William.
Watson-Stillman Co.
Williams Valve Co., D. T.

HYDRAULIC PRESSES AND OTHER MACHINERY
Chambersburg Engineering Co.
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.
Watson-Stillman Co.

HYDROGEN
International Oxygen Co.

HYDROGEN GENERATORS
International Oxygen Co.

HYDROMETERS
Taylor Instrument Companies.

HYGRODEIKS
Taylor Instrument Companies.

HYGROMETERS
Taylor Instrument Companies.

ICE MACHINES
(See Refrigerating Machinery.)

INDICATOR CONNECTIONS
Lunkenheimer Co.
Powell Co., The William.

INDICATORS
(Steam and Gas Engine.)
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Cory, Chas., & Son, Inc.
Lonkenheimer Co., The.
Manning, Maxwell & Moore, Inc.
Powell Co., The William.
Williams, Wm. E.

INDUSTRIAL ENGINEERS
Jacobs, J. L., & Co.

INJECTORS
Lunkenheimer Co., The.
Manning, Maxwell & Moore, Inc.
Powell Co., The William.
Schutte & Koerting Co.
Williams, Wm. E.

INSULATING COVERINGS
Tubular Woven Fabric Co.

INTERLOCKING RUBBER TILING
Griscom-Russell Co.
New York Belting & Packing Co.

IRON
Harvey, Arthur C., Co.

IRON CEMENT
Smooth-On Mfg. Co.

IRON PIPE
(See Pipe.)

JACKS
(Pneumatic.)
Gracey, R., & Sons Co.
Independent Pneumatic Tool Co.
Watson-Stillman Co.

JACKS, HYDRAULIC
Watson-Stillman Co.

JACKS-STEAMBOAT RATCHET
(Pulling.)
Gracey, R., & Sons Co.
Griscom-Russell Co.

JOURNAL BEARINGS
(See Thrust Bearings.)

JUTE
American Mfg. Co.
Columbian Rope Co.

KEROSENE ENGINES
Consolidated Shipbuilding Corp.
Fairbanks, Morse & Co.
Hush, H. J.
Mietz Machine Works.
Standard Motor Construction Co.
Winton Engine Works.

KNIFE SWITCHES
Crouse-Hinds Co.

LADDERS
Irving Iron Works Co.
Universal Safety Tread Co.

LADDER TREADS
Irving Iron Works Co.
Universal Safety Tread Co.
Williams, Wm. E.

LAMPS, SIGNALS AND FIXTURES
Cory, Chas., & Son, Inc.
General Electric Co.
Sands, A. B., & Son Co.
Seidler-Miner Co., Inc.
Western Electric Co.
Westinghouse Electric & Mfg. Co.
Williams, Wm. E.

LATHE DOGS
Williams & Co., J. H.
Williams, Wm. E.

LATHES, CRANK SHAFT, ENGINE AND TURRET
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.

LAUNCHES AND YACHTS
(See Shipbuilders.)

LAUNCHING GREASE
Sun Co.
Texas Co., The.

LAVATORIES
(Stateroom.)
Crane Co., The.
Mott Iron Works, J. L.
Sands, A. B., & Son Co.
Williams, Wm. E.

LAVATORY AND BATH HEATERS
Griscom-Russell Co.
Sands, A. B., & Son Co.
Williams, Wm. E.

LEAD PENCILS
(See Drawing Pencils.)

LEATHER BELTING
Williams, Wm. E.

LIFE BOATS AND RAFTS
American Balsa Co.
Lane Lifeboat Co., C. M.
Neptune Boat Works.
Pride, Guy R., & Son.
Steward Davit & Equip. Corp.
Williams, Wm. E.

LIFE PRESERVERS
American Balsa Co.
Ferdinand, L. W., & Co.
Williams, Wm. E.

LIFE-SAVING DEVICES
American Balsa Co.
Steward Davit & Equip. Corp.
Williams, Wm. E.

LIGHTING SETS
(See Electric Plants.)

LIGHTS, ELECTRIC
(See Electric Lights.)

LINES—TOWING, BUOY
(See Rope.)

LINOLEUM CEMENT
Ferdinand & Co., L. W.

LIQUID GLUE, WATERPROOF
Ferdinand & Co., L. W.

LOADING AND UNLOADING EQUIPMENT
(See Freight-Handling Equipment.)

LOCKS AND LATCHES
(See Ship Locks and Latches.)

LOCOMOTIVE CRANES
(See Cranes.)

LOG REGISTERS
American Balsa Co.
Hand, John E., & Sons Co.

LOWERING CONTROL
American Balsa Co.
Morse Dry Dock & Repair Co.
Steward Davit & Equip. Corp.

LUBRICANTS
Cook's Sons, Adam.
Dixon Crucible Co., Jos.
Sun Co.
Texas Co., The.
Wadsworth, Howland & Co.
Williams, Wm. E.

LUBRICATING COMPOUND
Cook's Sons, Adam.

LUBRICATING STRAINERS
Schutte & Koerting Co.

LUBRICATORS
Cook's Sons, Adam.
Crane Co.
Griscom-Russell Co.
Lunkenheimer Co.
Powell Co., The William.
Sun Co.
Williams Valve Co., D. T.

LUMBER
Long-Bell Lumber Co.
Morse Dry Dock & Repair Co.

MACHINISTS
Thacher Propeller & Foundry Corp.

MACHINE GUARDS
Page Steel & Wire Co.

MACHINE TOOLS
Cleveland Pneumatic Tool Co.
Cleveland Punch & Shear Works Co.
Niles-Bement-Pond Co.
Pratt & Whitney Co.
Ryerson, Jos. T., & Son.

MACHINISTS' TOOLS
Williams & Co., J. H.

MANGANESE BRONZE CASTINGS
American Manganese Bronze Co.
Columbian Bronze Corp.
Cramp, Wm., & Sons, Ship & Engine Bldg. Co.
Griscom-Russell Co.
Hyde Windlass Co.
Lunkenheimer Co.
Powell Co., The William.

MAGNESIA GOODS AND MATERIALS
Magnesia Association of America.

MALLEABLE AND STEEL CASTINGS
Crane Co.
Malleable Iron Fittings Co.

MANDRELS
Pratt & Whitney Co.

MANHOLES
Rnerson, Jos. T., & Son.
Thacher Propeller & Foundry Corp.

MANILA AND SISAL ROPE
(See Rope.)

MANIFOLDS
Cleveland Pneumatic Tool Co.

MANUFACTURING PLANTS
(See Builders.)

MARINE BOILER HEADS
(See Boiler Heads.)

MARINE CABLEWAYS
Lidgerwood Mfg. Co.

MARINE COATINGS
(See Anti-Rust Coatings.)

MARINE DECKING
(See Decking.)

MARINE ELECTRICAL EQUIPMENT
(See Electrical Fittings and Supplies.)

MARINE ENGINES
(See Engines, Propelling.)

MARINE ENGINEERS
(See Engineers, Consulting.)

MARINE FORGINGS
(See Forgings.)

MARINE GLUE
Ferdinand & Co., L. W.
Williams, Wm. E.

MARINE HARDWARE
Bridgeport Brass Co.
Consolidated Shipbuilding Corp.
Ferdinand & Co., L. W.
Rostand Mfk. Co.
Sands & Son Co., A. B.
Thacher Propeller & Foundry Corp.
Tiebout, W. & J.
Waterbury Mfg. Co.
Wilcox, Crittenden & Co., Inc.
Williams, Wm. E.

MARINE HEATERS
(See Heaters.)

MARINE INTER-COMMUNICATION EQUIPMENT
Cory, Chas., & Son, Inc.
Western Electric Co.

MARINE LIGHTING SETS
(See Electric Plants.)
Williams, Wm. E.

MARINE PAINT
(Also see Paint.)
Briggs Bituminous Composition Co., Inc.
Dixon Crucible Co., Jos.
Federal Composition & Paint Co., Inc.
International Compositions Co.
Sherwin-Williams Co.
Wadsworth, Howland & Co.
Wailes Dove-Hermiston Corp.
Williams, Wm. E.

MARINE PLUMBING
Crane Co., The.
Mott Iron Works, J. L.
Sands & Son Co., A. B.

MARINE RAILWAY BUILDERS
Crandall Engineering Co.

MARINE RAILWAYS
(See Dry Docks.)

MARINE RANGES
(See Ranges.)

MARINE REFRIGERATION
(See Refrigerating Machinery.)

MARINE REPAIRS
(See Shipbuilders.)

MARINE SECURITIES
Marine Corporation.

MARINE SHAFTING
(See Shafting.)

MARINE SPECIALTIES
(See Steam Specialties.)

MARINE SUPERHEATERS
Babcock & Wilcox Co.
Badenhausen Co.
Heine Safety Boiler Co.
Locomotive Superheater Co.
Power Specialty Co.

MARINE SUPPLIES
Ferdinand & Co., L. W.
Tiebout, W. & J.
Williams, Wm. E.

MARINE WIRING DEVICES
Benjamin Electric Mfg. Co.
Conlan Electric Co.
Cory, Chas., & Son, Inc.
General Electric Co.
Seidler-Miner Co., Inc.
Western Electric Co.

MASTS, TUBULAR STEEL
National Tube Co.

MATTRESSES
Bernstein Mfg. Co.
Foster Bros. Mfg. Co.
Southern-Rome Co.

MECHANICAL TELEGRAPHS
Chadburn (Ship) Telegraph Co.
Cory, Chas., & Son, Inc.
Radio Corporation of America.
Williams, Wm. E.

METALLIC PACKING
(Also see Packing.)
France Packing Co.
Goetze Gasket & Packing Co.
Martell Packings Co.
U. S. Metallic Packing Co.

METERS, ELECTRIC
General Electric Co.
Western Electric Co.
Weston Elec. Instrument Co.

MILLING MACHINES
Niles-Bement-Pond Co.
Ryerson, Jos. T., & Son.
Standard Tool Co.

MINERAL WOOL
(See Non-Conducting Covering.)

MONEL METAL
International Nickel Co.

MOORING ENGINES
American Engineering Co.
Dake Engine Co.
Flory Mfg. Co., S.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Maine Elertric Co.
Mundy, J. S., Hoisting Eng. Co.
National Hoisting Engine Co.

MOORING FIXTURES
Penn Seaboard Steel Corp.
Stevens-Aylsworth Co., Inc.
Thacher Propeller & Foundry Corp.

MOORING PORTS AND RINGS
Stevens-Aylsworth Co., Inc.

MOTOR BOATS
(See Launches and Yachts.)

MOTOR BOAT SUPPLIES
Ferdinand & Co., L. W.
Tiebout, W. & J.
Williams, Wm. E.

MOTORS, ELECTRIC
Fairbanks, Morse & Co.
General Electric Co.
Western Electric Co.

MOTORS, GASOLINE
(See Gasoline Engines.)

MOTORS, STEAM
Steam Motors Co.

MOTOR TRUCKS
Packard Motor Truck Co.

MULTIPLE DRILLS
Niles-Bement-Pond Co.

MULTIPLE PUNCHES
Cleveland Punch & Shear Works.
Niles-Bement-Pond Co.
Thomas Spacing Machine Co.

MULTIWHIRL OIL COOLERS
Griscom-Russell Co.

NAILS
Malleable Iron Fittings Co.
Ryerson, Jos. T., & Son.

NAUTICAL INSTRUMENTS
Hand, John E., & Sons Co.
McNab Co., The.
Sperry Gyroscope Co.
Williams, Wm. E.

NAVAL ARCHITECTS
Bogert, John L.
Chapman & Fisher.
Cox & Stevens.
Donnelly, William T.
Ferris, Theodore.
Haight, Robert S.
Hansen, Max.
Harris, Leonard B.
Hough, Edward S.
Lysholm, Henry, Inc.
McClelland, N. E., & Co., Ltd.
McKinlay, James.
Matthews, John B.
Nilson, Leonard J.
Watts, J. Murray.

NEEDLE VALVES
(See Valves.)

NIPPLES
Crane Co., The.
Lunkenheimer Co., The.

NON-CONDUCTING COVERINGS
Magnesia Association of America.
Morse Dry Dock & Repair Co.
Thorsen, P. S., & Co., Inc.

NON TOPPLING BLOCKS
American Balsa Co.

NOZZLES
(See Hose Nozzles.)

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(See Bolts and Nuts.)
Russell, Buprdsall & Ward Bolt & Nut Co.
Ryerson, Jos. T., & Son.
Waterbury Mfg. Co.
Williams, Wm. E.

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Long-Bell Lumber Co.

OAKUM
America Balsa Co.
American Mfg. Co.
Standard Oakum Co., George.
Wall Rope Works, Inc.

OIL
(See Lubricants.)

OIL BURNERS, FUEL
(See Fuel Oil Burners.)

OIL BURNING EQUIPMENT
Kinney Mfg. Co.
Pommer, Walter C
Schutte & Koerting Co.
Wayne Oil Tank & Pump Co.
White Fuel Oil Engineer'g Corp.
Williams, Wm. E.

OIL CANS
National Marine Lamp Co.

OIL COOLERS
Griscom-Russell Co.
Ross Heater & Mfg. Co.
Schutte & Koerting Co.

OIL CUPS
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Crane Co.
Griscom-Russell Co.
Lunkenheimer Co.
Powell Co., The William.
Sun Co.
Waterbury Mfg. Co.
Williams Valve Co., D. T.
Williams, Wm. E.

OIL ENGINES
(See Engines, Oil.)

OIL FUEL
Sun Co.
Texas Co., The.

OIL FUEL APPARATUS
(See Oil-Burning Equipment.)

OIL FURNACES
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Baush Machine Tool Co.
Wayne Oil Tank & Pump Co.

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Lunkenheimer Co.
Powell Co., The William.
Union Water Meter Co.
Williams Valve Co., D. T.
Williams, Wm. E.

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Ross Heater & Mfg. Co.
Row & Davis, Engineers, Inc.
Schutte & Koerting Co.

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Davidson, M. T., Co.
Dean Bros. Steam Pump Works.
Kinney Mfg. Co.
Lunkenheimer Co.
Powell Co., The William.
National Transit Pump & Machine Co.
Ross Heater & Mfg. Co.
Steam Motors Co.
Sands, A. B., & Son Co.
Terry Steam Turbine Co.
Williams Valve Co., D. T.
Worthington Pump & Mach. Corp.

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Griscom-Russell Co.
Schutte & Koerting Co.

OIL TANKS
Stevens-Aylsworth Co., Inc.

OIL TANKERS
(See Tank Ships.)

OILING SYSTEMS
(Also see Lubricants.)
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Lunkenheimer Co.
Powell Co., The William.

ORE-HANDLING MACHINERY
(See Coal-Handling Machinery.)

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Oxweld Acetylene Co.
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Vulcan Iron Works, Inc.

OXYGEN
International Oxygen Co.
Linde Air Products Co.
Oxweld Acetylene Co.
Prest-O-Lite Co.

OXYGEN GENERATORS
International Oxygen Co.

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France Packing Co.
Goetze Gasket & Packing Co.
Johns-Pratt Co.
Martell Packings Co.
New York Belting & Packing Co.
United States Metallic Packing Co.
Williams, Wm. E.

PACKING, ASBESTOS
Crane Co.
Morse Dry Dock & Repair Co.
New York Belting & Packing Co.
Williams, Wm. E.

PACKINGS, LEATHER
Watson-Stillman Co.

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Federal Composition & Paint Co.
International Compositions Co.
Marine Decking & Supply Co.
Sherwin-Williams Co.
Texas Co., The.
Wadsworth, Howland & Co.
Wailes Dove-Hermiston Corp.
Williams, Wm. E.

PAINT SPRAYING EQUIPMENT
(See Pneumatic Paint Spraying Equipment.)

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Cory, Chas., & Son, Inc.
Crouse-Hinds Co.

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(Marine Fireproof.)
Marine Decking & Supply Co.

PARTITIONS
(Marine Fireproof.)
Marine Decking & Supply Co.

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PATTERNS
Thacher Propeller & Foundry Corp.

PENCILS
(See Drawing Pencils.)

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Columbian Bronze Corp.
Griscom-Russell Co.
Hyde Windlass Co.
Lunkenheimer Co.

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Lidgerwood Mfg. Co.
McMyler-Interstate Co.
Mundy Hoisting Eng. Co., J. S.

PIPE
American Spiral Pipe Works.
National Tube Co.
Reading Iron Co.
Watson-Stillman Co.
Williams, Wm. E.

PIPE BENDING MACHINES
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Baird Pneumatic Tool Co.
Buffalo Forge Co.
Ryerson, Jos. T., & Son.
Watson-Stillman Co.

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(See Non-Conducting Covering.)

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Williams, Wm. E.

PIPE EXPANDING AND FLANGING MACHINES
Watson-Stillman Co.

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(See Flanges.)

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Dart Mfg. Co.
Lunkenheimer Co., The.
Powell Co., The William.
Williams Valve Co., D. T.
Williams, Wm. E.

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Metal & Thermit Corp.

PIPE WRENCHES
Williams & Co., J. H.
Williams, Wm. E.

PISTON RINGS
(See Packings.)

PISTON RODS
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Ryerson, Jos. T., & Son.

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Williams, Wm. E.

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PLATE CASTORS
(See Castors.)

PLATE PUNCH TABLES
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PLATE SHEARS
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PLATES
(See Steel Plates and Shapes.)

PLUGS AND RECEPTACLES—WATERTIGHT
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Williams, Wm. E.

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Williams, Wm. E.

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(See Marine Plumbing.)

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(See Pneumatic Tools.)

PNEUMATIC HAMMERS
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Keller Pneumatic Tool Co.
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Ryerson, Jos. T., & Son.
Watson-Stillman Co.

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Cleveland Pneumatic Tool Co.
Chicago Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Keller Pneumatic Tool Co.
Nazel Engineering & Mach. Co.
Oldham, George, & Son Co.

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Ashton Valve Co.
Crane Co.
Dew Valve Co.
Lunkenheimer Co.
Powell Co., The William.
Williams, Wm. E.

POPPET VALVES
(See Valves.)

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General Electric Co.
Lynd-Farquhar Co.

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Baird Pneumatic Tool Co.

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(See Air Ports.)

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POWER PUNCHES
Watson-Stillman Co.

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Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Niles-Bement-Pond Co.
Oldham, George, & Son Co.
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Watson-Stillman Co.

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Crane Co.
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Chapman & Fisher.
Churchill & MacLeod.
Ferris, Theodore.
Haight, Robert S.
Hough, Edward S.
Lysholm, Henry, Inc.
Matthews, John B.
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Nilson, Leonard J.
Pommer, Walter E.
Watts, J. Murray.

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(See Shafting.)

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Trout Co., H. G.

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Schutte & Koerting Co.
Williams, Wm. E.

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(See Engines, Pumping.)

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Chambersburg Engineering Co.
Davidson Co., M. T.
Dean Bros. Steam Pump Works.
De Laval Steam Turbine Co.
Fairbanks, Morse & Co.
Griscom-Russell Co.
Howden, James, & Co.
Hush, H. J.
Hyde Windlass Co.
Kinney Mfg. Co.
Morris Machine Works.
National Transit Pump & Machine Co.
Row & Davis, Engineers, Inc.
Sands & Son Co., A. B.
Terry Steam Turbine Co.
Watson-Stillman Co.
Wheeler Condenser & Eng. Co.
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(See Spacing Tables.)

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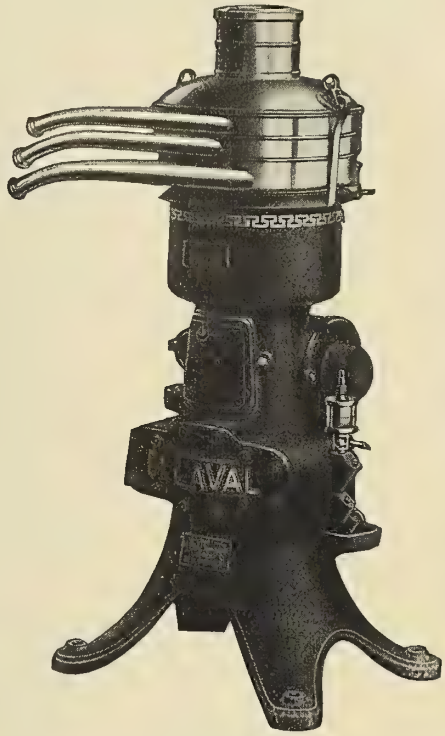

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McNab Co., The.
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Pedrick Tool & Machine Co.

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(See Valves.)

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(See Plumbing.)

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General Electric Co.
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Western Electric Co.

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(See Valves.)

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Admiral Anchor Co.
Baldt Anchor Co.

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(See Steel Shafting.)

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Heppenstall Forge & Knife Co.
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Morse Dry Dock & Repair Co.
National Tube Co.
Pollak Steel Co.
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Williams, Wm. E.

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Chase Rolling Mill Co.

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Staten Island Shipbuilding Co.
Todd Shipyards Corp.
Union Dry Dock & Repair Co.,
Vulcan Iron Works, Inc.
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(See Cranes.)

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Hough, Edward S.
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(See Clocks.)

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(See Cowls.)

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(See Dry Docks and Marine Railways.)

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(See Rivets.)

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(See Lumber.)

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Duratex Co.

SHIPYARDS
(See Shipbuilders.)

SHIPYARD CRANES
(See Cranes.)

SHIPYARDS WHIRLERS
(See Cranes.)
O'Rourke Crane & Eng. Co.

SHOP CRANES
(See Cranes.)

SIGNALLING APPARATUS
Benjamin Electric Mfg. Co.
Cory, Chas., & Son, Inc.

SKYLIGHT LIFTING GEAR
Tiebout, W. & J.

SLEEVES
(See Sockets and Sleeves.)

SLITTING MACHINES
The Quickwork Co.

SLOTTING MACHINES
Niles-Bement-Pond Co.

SMALL TOOLS
(See Bench Tools.)

SMOOTH-ON
Smooth-On Mfg. Co.

SOAPS
Texas Co., The.
Williams, Wm. E.

SOCKETS AND SLEEVES
Pollak Steel Co.
Pratt & Whitney Co.
Williams & Co., J. H.

SOUNDING MACHINES
Hand, John E., & Son Co.
Williams, Wm. E.

SOUTHERN PINE
(See Lumber.)

SPACING TABLES WITH MULTIPLE PUNCHES
Thomas Spacing Machine Co.

SPECIAL COPPER WORK
Sands, A. B., & Son.
Williams, Wm. E.

SPEED INDICATORS FOR SHIPS
Cory, Chas., & Son, Inc.

SPLITTING SHEARS
The Quickwork Co.

SPIKES
Williams, Wm. E.

SPRAYING EQUIPMENT
Schutte & Koerting Co.
Spray Engineering Co.

SPROCKET RIMS
(See Adjustable Sprocket Rims.)

STABILIZERS
Sperry Gyroscope Co.

STAIRS AND STAIR TREADS
Irving Iron Works Co.

STANDARDIZED WOODWORK
Long-Bell Lumber Co.

STAYBOLT CUTTERS
Baird Pneumatic Tool Co.

STAYBOLT IRON
Harvey, Arthur C., Co.

STAYBOLT TAPS
(See Taps & Dies.)

STEAM ENGINES
(See Engines.)

STEAM GAUGES
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Crane Co., The.
Lunkenheimer Co.
Powell Co., The William.
Taylor Instrument Companies.
Williams Valve Co., D. T.
Williams, Wm. E.

STEAM HAMMERS
Chambersburg Engineering Co.
Niles-Bement-Pond Co.

STEAM HOISTS
(See Hoisting Engines.)

STEAM HOSE
Ingersoll-Rand Co.
New York Belting & Packing Co.

STEAM PIPE COVERINGS
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STEAM PUMPS
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STEAM SEPARATORS
Crane Co.
Griscom-Russell Co.
Schutte & Koerting Co.
Tracy Engineering Co.
Williams Valve Co., D. T.

STEAM SPECIALTIES
(See Pumps, Valves, Gauges, Lubricators, etc.)

STEAM SUPERHEATERS
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STEAM TRAPS
American Steam Gauge & Valve Mfg. Co.
Crane Co.
Griscom-Russell Co.
Mason Regulator Co.
Pratt & Cady Co., Inc.
Sands, A. B., & Son Co.
Union Water Meter Co.
Williams Valve Co., D. T.
Williams, Wm. E.

STEAM TURBINES
Alberger Pump & Condenser Co.
Bath Iron Works.
Bethlehem Shipbuilding Corp.
Cramp, Wm., & Sons Ship & Engine Bldg. Co.
De Laval Steam Turbine Co.
Fletcher, W. & A., Co.
General Electric Co.
Hallidie Co.
Howden, James, & Co.
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Parsons Marine Steam Turbine Co.
Terry Steam Turbine Co.
Vulcan Iron Works, Inc.
Western Eelectric Co.
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De Laval Steam Turbine Co.
General Electric Co.
Vulcan Iron Works, Inc.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

STEEL (FOR SHIPBUILDING PURPOSES)
Harvey Co., Arthur C.

STEEL BALLS
Bantam Ball Bearing Co.
Gwilliam Co., The.

STEEL CASTINGS
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STEEL MASTS
Great Lakes Engineering Works.

STEEL PIPE
Crane Co.
National Tube Co.

STEEL PLATES
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STEEL PLATE CONSTRUCTION
Heine Safety Boiler Co.

STEEL PLATES AND SHAPES
Harvey, Arthur C., Co.
Lukens Steel Co.
Penn Seaboard Steel Corp.
Ryerson, Jos. T., & Son.

STEEL SHAFTING
(See Shafting.)

STEEL TANKS
Heine Safety Boiler Co.
Stevens-Aylsworth Co., Inc.
Wayne Oil Tank & Pump Co.

STEERING ENGINES
Allan-Cunningham Co.
American Engineering Co.
Dake Engine Co.
Hadfield-Penfield Steel Co.
Hyde Windlass Co.
Kearfott Engineering Co.
Lidgerwood Mfg. Co.
Maine Electric Co.
Maritime Engineering & Sales Corp.
Mundy Hoisting Engine Co., J. S.
National Hoisting Engine Co.

STEERING GEARS
Allan-Cunningham Co.
American Engineering Co.
Dake Engine Co.
Howden, James, & Co.
Hadfield-Penfield Steel Co.
Hyde Windlass Co.
Lidgerwood Mfg. Co.
Maine Electric Co.
Maritime Engineering & Sales Corp.
Mundy Hoisting Engine Co., J. S.
National Hoisting Engine Co.
National Marine Engine Works.

STEERING WHEELS
American Engineering Co.
Dake Engine Co.
Hadfield-Penfield Steel Co.
Hand, John E., & Sons Co.
Hyde Windlass Co.
McNab Co., The.

STEMS
Penn Seaboard Steel Corp.

STEPS—SAFETY GRATING
Irving Iron Works Co.
Universal Safety Tread Co.

STERN FRAMES AND TUBES
Hardie-Tynes Mfg. Co.
Penn Seaboard Steel Corp.

STOP COCKS
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STOVES
(See Ranges.)

STRAIGHTENING ROLLS
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SUPERHEATERS
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SUPERHEATER TUBES
National Tube Company.

SULPHURIC ACID
New Jersey Zinc Co.

SURFACE CONDENSERS
Davidson Co., M. T.
Ross Heater & Mfg. Co.
Wheeler Mg. Co., C. H.
Williams, Wm. E.

SURVEYING INSTRUMENTS
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New York Blue Print Paper Co.

SWIVELS
Williams & Co., J. H.

SWITCHES AND SWITCHBOARDS
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TACHOMETERS
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TACKLE BLOCKS
Williams, Wm. E.

TAIL SHAFTS
(See Shafting.)

TANKS
(Copper, Galvanized Iron.)
Bath Iron Works.
Fairbanks, Morse & Co.
Griscom-Russell Co.
Sands, A. B., & Sons Co.
Stevens-Aylsworth Co., Inc.

TANKS FOR OIL, GASOLINE, KEROSENE, ETC.
Pneumercator Co.

TANK GAUGES
Wayne Oil Tank & Pump Co.

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Bath Iron Works.
Merchant Shipbuilding Corp.
Newport News Shipbuilding & Drydock Co.

TANK PUMPS
Davidson Co., M. T.

TANKS, SEAMLESS STEEL
Continental Iron Works, The.
National Tube Co.

TANKS, WELDED STEEL
Continental Iron Works, The.
Stevens-Aylsworth Co., Inc.

TAPERED LINERS
Irving Iron Works Co.

TAPS AND DIES
Brubaker, W. L., & Bros.
Pratt & Whitney Co.
Standard Tool Co.
Williams, Wm. E.

TARRED HEMP ROPE
Ajax Rope Co.
American Mfg. Co.
Wall Rope Works.
Whitlock Cordage Co.
Williams, Wm. E.

TEES—ROLLED STEEL
Harvey, Arthur C., Co.
Pollak Steel Co.
Ryerson, Jos. T., & Son.

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(See Mechanical Telegraphs.)

TELEGRAPH FITTINGS, CHAIN AND WIRE
Cory, Chas., & Son, Inc.

TELEGRAPH FITTINGS AND VOICE TUBES AND FITTINGS
Cory, Chas., & Son, Inc.
Tiebout, W. & J.

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American Engineering Co.
Hyde Windlass Co.
Maritime Engineering & Sales Corp.

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(Also see Ship Telephones.)
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Radio Corp. of America.
Western Electric Co.

THERMIT WELDING
Metal & Thermit Corp.
Powell Co., The William.
Schutte & Koerting Co.

THERMOMETERS
Hand, John E., & Sons Co.
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Companies.
Williams, Wm. E.

THRUST BEARINGS
(See Ball Bearings and Roller Bearings.)

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(See Interlocking Rubber Tiling.)

TOOL STEEL
Harvey, Arthur C., Co.
Ryerson, Jos. T., & Son.

TOOLS, MACHINE
(See Machine Tools.)

TOOL HOLDERS
Williams & Co., J. H.

TORSION METERS
McNab Co., The.

TOWER CRANES
Maine Electric Co.
Mead-Morrison Mfg. Co.

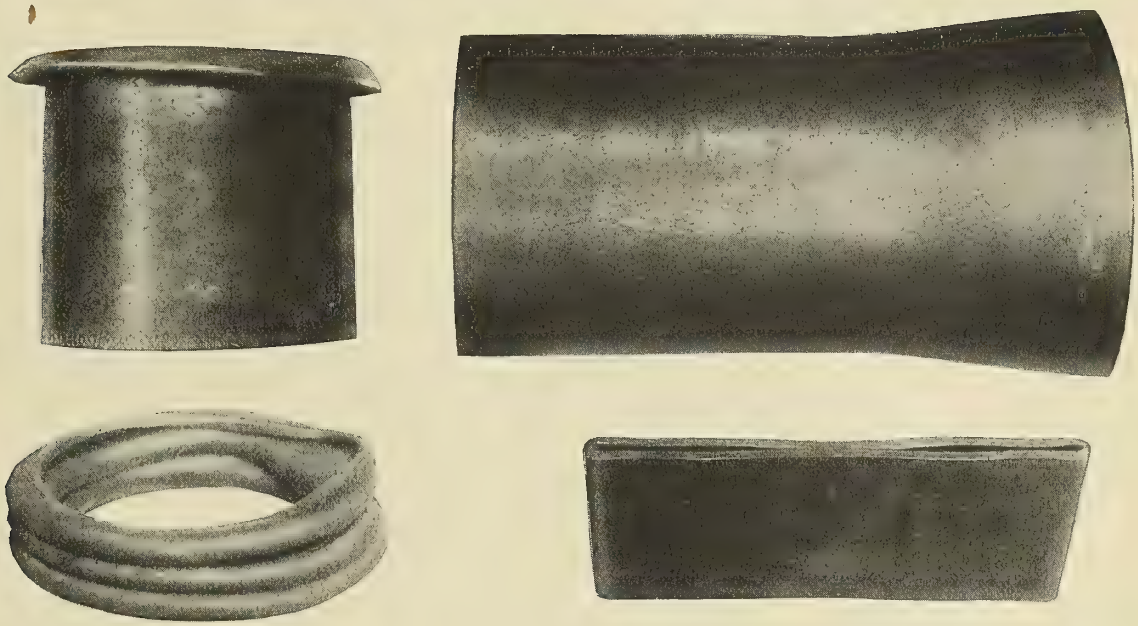
TOWING HOOKS AND COCKS
American Engineering Co.

TOWING LINES
(See Rope and Wire Rope.)

"SHELBY"

The Recognized Standard of

SEAMLESS BOILER TUBES



TESTS made on "SHELBY" SEAMLESS BOILER TUBES parallel to some extent the tests of actual service, and are a good indication of what may be expected under operating conditions. The ductility required for successful flanging, expanding and beading is well indicated in the illustrations above, as is the ability to resist the various forces present under operating conditions. While all of the tests shown were made cold, experience has proved that the same satisfactory results are obtained under the high temperatures and sudden changes of temperature found in actual service.

¶ "SHELBY" boiler tubes are singularly uniform, strong and ductile and are made by an organization with fifty years of experience in the manufacture of wrought tubular products.

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EXPORT REPRESENTATIVES: U. S. Steel Products Company New York City

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American Engineering Co.
Dake Engine Co.
Lidgerwood Mfg. Co.
Maritime Engineering & Sales Corp.

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National Tracing Cloth Co.

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(See Rope.)

TRAPS
(See Steam Traps.)

TRAVELING CRANES
(See Cranes.)

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Brown Hoisting Machinery Co.
McMyler Interstate Co.
Whiting Foundry Equipment Co.

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Packard Motor Truck Co.
Towmotor Co., The.

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TUBES, RODS, WIRES
(Copper, Brass and Bronze.)
Chase Metal Works.
Chase Rolling Mill Co.
International Nickel Co.
Standard Underground Cable Co.
Williams, Wm. E.

TUBE CLEANERS
(See Boiler Flue Cleaners.)

TUBE EXPANDERS
(See Boiler Flue Expanders.)

TUGS
(See Shipbuilders.)

TURBINES
(See Steam Turbines.)

TURNBUCKLES AND OTHER WIRE ROPE ACCESSORIES
American Engineering Co.
Broderick & Bascom Rope Co.
Durable Wire Rope Co.
Waterbury Co.
Williams & Co., J. H.
Williams, Wm. E.

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American Engineering Co.

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(See Lathes, Turret.)

TWINE
(See Rope; also Cordage.)
Ajax Rope Co.
American Mfg. Co.
Columbian Rope Co.
Plymouth Cordage Co.
Samson Cordage works.
Waterbury Co.
Whitlock Cordage Co.
Williams, Wm. E.

TWIST DRILLS
Pratt & Whitney Co.
Rich Tool Co.
Standard Tool Co.
Williams, Wm. E.

UNDERWRITERS' AGENTS
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UNIONS
(See Pipe Unions.)

UPHOLSTERY
(See Ship Upholstery.)

UPHOLSTERY MATERIALS—WATERPROOF
Duratex Co.

VACUUM GAUGES
(See Steam Gauges.)

VACUUM PUMPS
Davidson, M. T., Co.
Dean Bros. Steam Pump Works.
Ingersoll-Rand Co.
Ross Heater & Mfg. Co.
Westinghouse Electric & Mfg. Co.
Wheeler Mfg. Co.
Worthington Pump & Mach. Corp.

VACUUM TRAPS
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Griscom-Russell Co.
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Leavitt Machine Co.

VALVES
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Crane Co.
Dew Valve Co.
Griscom-Russell Co.
Jerguson Valve Mfg. Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Mason Regulator Co.
Powell Co., The William.

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Sands, A. B., & Son Co.
Schutte & Koerting Co.
Union Water Meter Co.
Watson-Stillman Co.
Williams Valve Co., D. T.
Williams, Wm. E.

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Frick Co.
Pratt & Cady Co., Inc.
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VALVES—CHRONOMETER
(See Chronometer Valves.)

VALVES—RUBBER
Powell Co., The William.
Pratt & Cady Co., Inc.
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Schutte & Koerting Co.
Williams, Wm. E.

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Chambersburg Engineering Co.
Crane Co.
Jerguson Gage & Valve Co.
Lunkenheimer Co.
Mason Regulator Co.
Powell Co., The Wm.
Sands, A. B., & Son Co.
Schutte & Koerting Co.
Union Water Meter Co.
Williams Valve Co., D. T.
Williams, Wm. E.

VAPOR PROOF FITTINGS
(See Waterproof Fittings.)

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Long-Bell Lumber Co.

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(See Blowers.)

VENTILATORS
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Sands, A. B., & Son Co.
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Thacher Propeller & Foundry Corp.

VERTICAL PUMPS
(See Pumps.)

VESSEL BROKERS
(See Ship Brokers.)

VISES—CHAIN PIPE, CLAMP, MOUNT
Williams & Co., J. H.
Williams, Wm. E.

VOICE TUBES AND FITTINGS
Chase Metal Works.
Chase Rolling Mill Co.
Cory, Chas., & Son, Inc.
Rostand Mfg. Co.

WALKWAY GRATINGS
Irving Iron Works Co.

WALL RADIAL DRILLS
(See Radial Drills.)

WATER CLOSETS, MARINE
(See Plumbing.)

WATER COLUMNS
Crane Co.
Jerguson Gage & Valve Co.
Lunkenheimer Co.
National Tube Co.

WATER GAUGES AND ALARMS
Cory, Chas., & Son.
Crane Co.
Jerguson Gage & Valve Co.
Lunkenheimer Co.
Powell Co., The William.
Williams Valve Co., D. T.

WATER METERS
Union Water Meter Co.

WATERPROOFING FOR FABRICS
Robeson Preservo Co.

WATERPROOF LIQUID CEMENT
Ferdinand, L. W., & Co.

WATERPROOF LIQUID GLUE
Ferdinand, L. W., & Co.

WATERPROOF PAINT
Dixon, Joseph, Crucible Co.
International Composition Co.

WATERTUBE BOILERS
(See Boilers.)
Almy Watertube Boiler Co.
Heine Safety Boiler Co.
Ward Engineering Works, Chas.

WATER VALES
(See Valves, Water.)

WATTMETERS
(See Electrical Instruments.)

WELDING AND WELDING AND CUTTING APPARATUS AND SUPPLIES
(Oxy-acetylene Process.)
Metal & Thermit Corp.
Morse Dry Dock & Repair Co.
Oxweld Acetylene Co.
Prest-O-Lite Co., Inc.
Vulcan Iron Works, Inc.

WELDING, ELECTRIC
General Electric Co.
Vulcan Iron Works, Inc.

WELDING METALS
(See Welding and Cutting Apparatus and Supplies.)

WELDING, REPAIRS
Cramp, Wm., & Son Ship & Engine Bldg. Co.
Metal & Thermit Corp.

WELDING RODS OF ALL KINDS
Camden Forge Co.
Cramp, Wm., & Son Ship & Engine Bldg. Co.
Metal & Thermit Corp.
Oxweld Acetylene Co.
Prest-O-Lite Co., Inc.
Vulcan Iron Works, Inc.

WELDING WIRE
Cramp, Wm., & Son Ship & Engine Bldg. Co.
Harvey, Arthur C., Co.

WHARF CRANES
(See Cranes.)

WHARF DROPS
American Engineering Co.

WHISTLES
American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Crane Co.
Lunkenheimer Co.
Powell Co., The William.
Sands, A. B., & Son Co.
Union Water Meter Co.
Williams, Wm. E.

WHISTLE CONTROL
Cory, Chas., & Son, Inc.
Lunkenheimer Co.

WINCHES
(See Windlasses.)
Allan-Cunningham Co.
Mead-Morrison Mfg. Co.
Maritime Engineering & Sales Corp.

WINDLASSES
Allan-Cunningham Co.
American Engineering Co.
American Ship Building Co.
Bethlehem Shipbuilding Corp.
Dake Engine Co.
Flory, S., Mfg. Co.
Hadfield-Penfield Steel Co.
Hallidie Co., N.
Hush, H. J.
Hyde Windlas Co.
Kearfott Engineering Co.
Lidgerwood Mfg. Co.
Maine Electric Co.
Maritime Engineering & Sales Corp.
Mead-Morrison Mfg. Co.
Mundy, J. S., Hoisting Eng. Co.
National Hoisting Engine Co.
Rostand Mfg. Co.

WIRE (FOR ALL ELECTRICAL PURPOSES)
Benjamin Electric Mfg. Co.
Goodell-Pratt Co.
Habirshaw Electric Cable Co.
Page Steel & Wire Co.
Standard Underground Cable Co.

WIRE COVERINGS
Tubular Woven Fabric Co.

WIRE ROPE, CABLES AND ACCESSORIES
Ajax Rope Co.
American Engineering Co.
Broderick & Bascom Rope Co.
Durable Wire Rope Co.
Granger, George B., Co.
Waterbury Co.
Wickwire Spencer Steel Corp.
Williams, Wm. E.

WIRELESS APPARATUS AND TELEGRAPHS
Cutting & Washington Radio Corp.
Radio Corporation of America.

WIRING DEVICES
(See Marine Wiring Devices.)

WIRING MACHINES
The Quickwork Co.

WOODWORKING MACHINERY
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.

WRECKING CABLES
Ajax Rope Co.
American Mfg. Co.
Columbian Rope Co.
Plymouth Cordage Co.
Wall Rope Works.
Waterbury Co.
Whitlock Cordage Co.

WRECKING PUMPS
Dacidson Co., M. T.

WRENCHES
(Also Pipe Wrenches.)
Coes Wrench Co.
Williams & Co., J. H.
Williams, Wm. E.

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YACHTS
(See Launches and Yachts.)

YELLOW PINE
Long-Bell Lumber Co.

YOKE CHRONOMETERS VALVES
Union Water Meter Co.
Williams, Wm. E.

ZINC DUST
New Jersey Zinc Co.
Williams, Wm. E.

ZINC PLATES
New Jersey Zinc Co.
Williams, Wm. E.

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